# USAID/PAKISTAN 2014 PROGRAMMATIC PERSUAP

## (PESTICIDE EVALUATION REPORT AND SAFE USE ACTION PLAN)

Alan Schroeder, PhD, MBA
Muhammad Aslam, PhD

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Authors:

Alan Schroeder, PhD, MBA
Muhammad Aslam, PhD

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Programmatic PERSUAP for the Pakistan USAID Mission

# ACRONYMS

| | |
|---|---|
| ABP | Pakistan Agribusiness Project |
| A/COR | Administrative/Contracting Officer's Representative |
| ADB | Asian Development Bank |
| ADP-B | Area Development Programme-Baluchistan (UNDP) |
| AESA | Agro Eco System Analysis |
| AGFUND | Arab Gulf Program for Development |
| AID | US Agency for International Development (also known as USAID) |
| AJK | Azad Jammu Kashmir |
| AN | Ammonium Nitrate (a fertilizer) |
| ANE | Asia and Near East (Bureau of USAID) |
| APO | Agricultural Pesticides Ordinance (Pakistan) |
| APTAC | Agricultural Pesticides Technical Advisory Committee (Pakistan) |
| AQD | Animal Quarantine Department |
| ASEAN | Association of Southeast Asian Nations |
| ASF | Agribusiness Support Fund |
| AVC | Agriculture Value Chains Project |
| BEO | Bureau Environmental Officer |
| BMP | Best Management Practice |
| BSE | Bovine spongiform encephalopathy (so-called mad cow disease) |
| BT | *Bacillus thuringiensis* (type of microbial-extract pesticide) |
| CABI | Commonwealth Agriculture Bureau International (now known as the British Consortium for Overseas Pest Management) |
| CAN | Calcium Ammonium Nitrate (a fertilizer) |
| CCD | Colony Collapse Disorder (honeybee colonies) |
| CE | Categorical Exclusion (a type of recommended environmental action) |
| CEC | Children's Ecological Clubs (Pakistan) |
| CEQ | Center on Environmental Quality |

| | |
|---|---|
| CFR | Code of Federal Regulations |
| CGIAR | Consultative Group for International Agriculture Research |
| CIBC | Commonwealth Institute of Biological Control |
| CIB & RC | Central Insecticides Board & Registration Committee (India) |
| cm | centimeters |
| COR | Contracting Officer's Representative (replaces as CTOR) |
| CRAMS | Contract Research and Manufacturing Services |
| CWA | Central and West Asia (part of CABI) |
| D | Deferral (a type of recommended environmental action) |
| DCHA | Democracy, Conflict and Humanitarian Assistance (USAID Bureau) |
| DEWS | Disease Early Warning System (Pakistan) |
| DFP | Dried Fruit Project |
| DPP | Department of Plant Protection (Pakistan) |
| E | Exemption (a type of recommended environmental action) |
| EA | Environmental Assessment |
| EC | Emulsifiable Concentrate (a pesticide formulation) |
| EPA | US Environmental Protection Agency (also known as USEPA) |
| EPE | Expatriate Pesticide Expert |
| EIS | Environmental Impact Statement |
| EMMPR | Environmental Mitigation and Monitoring Plans and Reports |
| ETL | Economic Threshold Level |
| EU | European Union |
| FAO | Food and Agriculture Organization (part of UN) |
| FAnGR | Farm Animal Genetic Resource |
| FATA | Federally Administered Tribal Area |
| FIFRA | Federal Insecticide, Fungicide and Rodenticide Act |
| FFS | Farmer Field School (program of FAO) |
| FSC&RD | Federal Seed Certification & Registration Department |
| g | grams |

| | |
|---|---|
| GAP | Good Agriculture Practices |
| GCP | Government Cooperative Programme (FAO) |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility (World Bank) |
| GlobalGAP | Global Good Agricultural Practices |
| GIZ | Gesellschaft für Internationale Zusammenarbeit (Germany) |
| GOP | Government of Pakistan |
| GMO | Genetically Modified Organism |
| GMP | Good Manufacturing Practices |
| GPU | Germ Plasm Unit |
| GQTL | Grain Quality Testing Laboratories |
| GUP | General Use Products (Pesticides for use by general public and non-certified farmers) |
| HACCP | Hazard Analysis and Critical Control Point |
| HCl | Hydrochloride |
| ILRI | International Livestock Research Institute |
| HMIS | Hazardous Materials Identification System |
| HPAI | Highly Pathogenic Avian Influenza |
| HPED | Highly Pathogenic and Emerging Diseases |
| HT | Highly Toxic |
| ICAMA | Institute for the Control of Agrochemicals of the Ministry of Agriculture (China) |
| ICARDA | International Center for Research in the Dry Areas (Syria) |
| ICRISAT | International Center for Research in Semi-Arid Tropics (India) |
| ID | Identification |
| IEE | Initial Environmental Examination |
| IGR | Insect Growth Regulator (a class of insecticide) |
| I-LED | Improving Livelihoods and Enterprise Development Program |
| IMF | International Monetary Fund |
| IPM | Integrated Pest Management |
| IPPC | International Plant Protection Convention |

| | |
|---|---|
| IRS | Indoor Residual Spraying (malaria) |
| ITN | Insecticide Treated Nets (malaria) |
| IUCN | International Union for Conservation of Nature |
| IVM | Integrated Vector Management |
| IWM | Integrated Weed Management |
| IWRM | Integrated Water Resources Management (IUCN Pakistan project) |
| JMPM | Joint Meeting on Pesticide Management (FAO and WHO) |
| KPK | Khyber Pakthunkhwa |
| LDP | Livelihood Development Program |
| LLIN | Long-Lasting Insecticidal Nets (WHO) |
| LLITN | Long-Lasting Insecticide Treated Nets |
| MAIL | Ministry of Agriculture, Irrigation and Livestock (Afghanistan) |
| MDG | Millennium Development Goals |
| MEO | Mission Environmental Officer |
| MFD | Marine Fisheries Department |
| mg | milligrams |
| MINFAL | Ministry of Food, Agriculture and Livestock (Pakistan) |
| MNC | Multi-National Corporation |
| MOH | Ministry of Health (Pakistan) |
| MRL | Minimum Residue Level (‘safe’ amount of pesticide on sold food) |
| MSDS | Material Safety Data Sheet |
| MT | Moderately Toxic |
| NAPHIS | National Animal and Plant Health Inspection Services |
| NAT | Not Acutely Toxic |
| NAT-IPM | National Integrated Pest Management Programme (Pakistan) |
| NARC | National Agricultural Research Centre (Pakistan) |
| NARS | National Agricultural Research Systems |
| Nat-IPM | National Integrated Pest Management Programme (Pakistan) |
| NCCW | National Council for Conservation of Wildlife (Pakistan) |

| | |
|---|---|
| ND | Negative Determination (a type of recommended environmental action) |
| ND/C | Negative Determination with Conditions (a type of recommended environmental action) |
| NEPA | National Environmental Protection Act (USEPA) |
| NGO | Non-Governmental Organization |
| NIH | National Institute of Health (Pakistan) |
| NIP | National Implementation Plan (under POPs Treaty) |
| NMDA | National Disaster Management Authority |
| NVL | National Veterinary Laboratories |
| NWFP | North West Frontier Province |
| OAPA | Office of Afghanistan and Pakistan Affairs |
| OECD | Organization for Economic Cooperation and Development |
| OFDA | Office of Foreign Disaster Assistance (office in USAID DCHA) |
| OIE | World Animal Health Organization |
| OP | Organophosphate (a class of pesticides) |
| PAN | Pesticide Action Network |
| PARC | Pakistan Agriculture Research Council |
| PC | Pakistani Consultant |
| PGR | Plant Growth Regulator |
| PTD | Positive Threshold Decision (a type of recommended environmental action) |
| PEA | Programmatic Environmental Assessment |
| PER | Pesticide Evaluation Report |
| PERSUAP | Pesticide Evaluation Report and Safer Use Action Plan |
| PPERSUAP | Programmatic PERSUAP (2014) |
| PIC | Prior Informed Consent (a treaty, relates to risky pesticides) |
| PMP | Pest Management Plan |
| PNPE | Pakistani National Pesticide Expert |
| PNT | Practically Non-Toxic |
| POPs | Persistent Organic Pollutants (a treaty, relates to toxic pesticides) |
| PPE | Personal Protection Equipment |

| | |
|---|---|
| PPMT | Production and Pest Management Plan |
| PPR | Peste Des Petits Ruminants |
| PRRO | Protracted Relief and Recovery Operations (program of WFP) |
| PTD | Positive Threshold Decision (a type of recommended environmental action) |
| PVO | Private Volunteer Organization |
| R&D | Research and Development |
| RBM | Roll Back Malaria (Program of UNWHO) |
| REI | Restricted Entry Interval |
| Reg, 216 | Regulation 216 (USAID Environmental Procedures) |
| RNE | Royal Netherlands Embassy |
| RUP | Restricted Use Product (Pesticides for use only by certified farmers/users) |
| SAARC | South Asian Association for Regional Cooperation |
| SME | Small and Medium Enterprises |
| SOW | Scope of Work |
| SPS | Sanitary and Phytosanitary |
| SS | Scoping Statement |
| ST | Slightly Toxic |
| STAP | Scientific and Technical Advisory Panel (WB/GEF) |
| SUAP | Safe Use Action Plan |
| TBT | Technical Barriers to Trade |
| TD | Threshold Decision |
| TES | Threatened and Endangered Species |
| TOF | Training of Facilitator |
| TOT | Training of Trainer |
| UAP | USAID's Agribusiness Project |
| UC | University of California |
| UK | United Kingdom |
| ULV | Ultra Low Volume (spray technology) |
| UN | United Nations |

| | |
|---|---|
| UNDP | United Nations Development Programme |
| UNESCO | UN Educational, Scientific and Cultural Organization |
| UNEP | United Nations Environment Programme |
| UNFAO | United Nations Food and Agriculture Organization |
| UNWFP | United Nations World Food Program |
| UNWHO | United Nations World Health Organization |
| U-PERSUAP | Umbrella PERSUAP (2011) |
| US | United States |
| USA | United States of America |
| USABBA | United States Assistance to Agricultural Development in Balochistan Border Areas |
| USAID | United States Agency for International Development |
| USDA | US Department of Agriculture |
| USEPA | US Environmental Protection Agency (also known as EPA) |
| USG | United States Government |
| VHT | Very Highly Toxic |
| WFT | Women Facilitators Training |
| WFP | World Food Program (UN) |
| WBG | World Bank Group |
| WHO | World Health Organization |
| WOS | Women Open Schools |
| WTO | World Trade Organization |
| WWW | World Wide Web |

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We also thank Pakistan Ministry of Agriculture staff and local farmers who were kind enough to receive our study and answer our questions during field visits and throughout the PERSUAP data collection, analysis and writing process.

We would like to highlight the admirable work that Weidemann is undertaking throughout Pakistan that will create employment, and improve the quality of life in these regions. Once again, in 2014, the E-NoeTec team wishes to thank Weidemann Associates and USAID for the opportunity to carry out this assessment and is confident that the findings and recommendations will benefit USAID projects across Pakistan.

# EXECUTIVE SUMMARY

This new 2014 Pakistan Programmatic PERSUAP (PPERSUAP) was developed for and under the direction of the USAID Mission to Islamabad in Pakistan via Prime Contract Number AID-OAA-TO-00017 for Agricultural Knowledge and Program Support Task Order, through Weidemann Associates Inc., using a Fixed Firm Price Sub Contract with E-NoeTec Consulting. It evaluates pesticides for USAID Pakistan's programs, projects and activities in response to recommendations found in IEEs (Initial Environmental Examinations) covering those programs.

This 2014 document includes new information, specifically covering a new sector of weed control around infrastructure like roads, irrigation canals, power lines and so on, as well as changes in pesticides newly-registered in Pakistan. This document also adds some minor crops not covered in previous PERSUAPs, such as mushrooms, currants, bay leaf, persimmon, Sea Buckthorne and honeybee products.

The "Programmatic" approach was used again to ensure compliance and facilitate implementation of programs and activities in the country, as well as economize resources such that each USAID Pakistan project would not need to duplicate costs and time to produce their own PERSUAP report. Moreover, the objective is to have one document that can guide activities where pesticides are or could be involved in any project in Pakistan and inform the USAID/Pakistan Mission A/CORs and MEO, as well as the Regional Environmental Advisor (REA) based in Almaty.

The main purpose of a Pesticide Evaluation Report (PER) and Safe Use and Action Plan (SUAP) is to bring USAID-funded projects into full compliance with USAID's environmental regulations (Title 22 of the Code of Federal Regulations (CFR), part 216, or Regulation 216) on pesticide use. Beyond compliance, this document offers best practices and helps ensure that the USAID-funded projects reduce the chances of environmental and health impacts due to pesticide training, promotion or use. USAID projects desiring to promote or use pesticides rejected by this PERSUAP analysis will need to perform an Environmental Assessment (EA) on those chemicals.

Risks are inevitably present with the use of pesticides and similar chemicals in several sectors including agricultural crop and livestock production, water treatment, avian influenza disinfection, construction, malaria/dengue prevention and weed control along infrastructure like roads and power lines. In addition to required compliance, there is an acute focus on the use of Good Agriculture Practices (GAPs) and Integrated Pest Management IPM) pest prevention tools.

USAID/Pakistan prohibits the procurement or use with USAID-provided funds of pesticides restricted by this PERSUAP. The Mission also prohibits the use of pesticides restricted by this PERSUAP in the implementation of USAID-funded activities. However, for activities outside the scope of USAID projects, the Mission does not, nor would it be possible to, restrict the procurement or use, or both, of any pesticide by recipients of USAID funds or participants in USAID-funded activities, so long as the funds used to procure such pesticides are not provided by USAID. For example, the Mission exercises no authority to restrict the use of pesticides on cotton crops by participants of a USAID-funded horticulture project, so long as the funds used to procure such pesticides are not provided by USAID.

# IMPORTANT PAKISTAN CROPS AND LIVESTOCK COVERED

- **Cereals/Small Grains:** Rice; Maize/Corn; Wheat/Winter Wheat; Barley/Winter Barley; Sorghum; Millet
- **Oil and Seed Crops:** Rape Seed/Canola; Mustard; Groundnut/Peanut; Sunflower; Safflower; Sesame; Linseed
- **Sugar Crops:** Sugarcane; Beets
- **Amaranthus Crop:** Spinach
- **Pulses:** Chickpea and Lentils; Mashbean; Urdbean; Green peas; Beans; Mungbeans
- **Solanaceous Crops:** Tomato; Potato; Chilies; Eggplant/Brinjal
- **Cole Crops/Crucifers:** Cabbage; Cauliflower; Broccoli
- **Cucurbits:** Cucumbers; Squashes; Pumpkins; Melons; Watermelon
- **Okra**
- **Alliums:** Onion, Garlic
- **Rhizome Spices:** Ginger, Turmeric
- **Brassicaceous:** Turnips; Radish
- **Umbelliferous:** Coriander
- **Forage/Fodder legumes:** Alfalfa/Lucerne; Berseem and other Clovers/Sainfoin/Espartset; Vetches; Trefoils
- **Stone Fruits/Drupes:** Apricot; Peach; Almond, Plum, Cherry
- **Pome Fruits:** Apple; Pear; Loquat; Quince
- **Pomegranate**
- **Mango**
- **Citrus**
- **Grapes**
- **Guava**
- **Dates**
- **Walnut**
- **Banana**
- **Papaya**
- **Livestock:** Cattle; Buffalo; Sheep; Goats; Donkey; Horse; Camel

**New for 2014**

- **Mushrooms**
- **Currants**
- **Persimmons**
- **Bay leaf**
- **Sea Buckthorn**
- **Honeybee Products**

# PRIMARY PERSUAP FINDINGS

This PERSUAP will closely inform the technical assistance and capacity building for USAID projects and their partners. It makes the following key findings and recommendations:

### PERSUAP/Allowed Pesticides

The 2014 Pakistan Programmatic PERSUAP evaluates pesticides that could be potentially supported (used on demo trials, promoted during training, assistance to obtain financing to purchase, direct procurement) with project and partner resources, as well as those that cannot be supported, including justifications.

### Safety Training/Equipment

Recommend that USAID projects and partners that support the use of pesticides on demo trials, promote the use of pesticides to farmers, or procure pesticides for farmers perform pesticide safety training and use Personal Protection Equipment (PPE).

### Spray Services

Recommend that USAID projects promote and support the concept and use of pesticide spray services that have well-trained and PPE-protected spray personnel.

### Good Agriculture Practices

Recommend that USAID project staff promote the use of state of the art Good Agriculture Practices (GAPs) for each of the five crops, including use of high yielding and quality seed, soil fertility testing and conservation, plant nutritional needs to grow healthy crops, proper water use, crop rotation, clean storage and marketing.

### Pest Management Plans/Integrated Pest Management

Recommend that USAID projects promote the use of state of the art (used by many international, national and state extension services) pest management plans (PMPs) containing major pests/diseases/weeds of each target crop, with preventive non-chemical Integrated Pest Management (IPM) tools/tactics, registered synthetic pesticides, as well as any artisanal and registered natural pesticides available.

# PRIMARY LESSONS LEARNED FROM PREVIOUS PERSUAPS/UPDATES

The previous 2011 Umbrella-PERSUAP (U-PERSUAP) and 2013 U-PERSUAP Update did not contain the sector for spraying ‘Rights of Way’, like along irrigation and transport canals, roads, powerlines, pipelines, runways, and around large construction sites with herbicides. This 2014 version includes this Rights of Way sector as potentially large quantities of herbicides may be used by USAID-funded proejcts.

Furthermore, it was noted in emails and questionnaires (see Annex 18) distributed to active USAID Pakistan projects that the previous U-PERSUAP/Update was missing the following minor, but important, Pakistan crops/products: mushrooms, currants, persimmons, bay leaf, Sea Buckthorne and honeybee products. This 2014 PPERSUAP rectifies this by covering these crops and products.

The 2014 questionnaires show that many Pakistani farmers and pesticide applicators still do not use complete PPE for applying pesticides, in spite of past efforts by USAID and other donors to change this. This is an area that requires more attention during training and resources, like subsidization of PPE to make it more affordable, in order to change farmer/pesticide applicator behavior.

The past 2013 U-PERSUAP Update guided USAID Pakistan projects on pesticides that could and could not be supported or used for their activities. Questionnaires to such projects indicate that they did not support or promote pesticides 'rejected' by the U-PERSUAP. USAID Pakistan projects must use this 2014 PPERSUAP to further this goal of informing projects so they do not inadvertently support or use pesticides that carry higher than normal risks.

The 2011/2013 U-PERSUAP/Update were used by the TAP project Scoping Exercise, and now this 2014 PPERSUAP covers analysis of all pesticides requested by TAP for horticulture, agriculture, food storage and livestock activities as well as small-scale construction requiring the use of termiticides. It also will be used for disinfectants for water sanitation and processing of agricultural products. Furthermore, the 2013 U-PERSUAP updated and replaced the lists of accepted, conditional and rejected pesticides applicable for the Federally Administered Tribal Areas (FATA)- Livelihood Development Program (LDP) program.

GOP officials given a copy of the 2011 PERSUAP while the 2013 U-PERSUAP Update progressed used that copy to make crop, pest, IPM and pesticide recommended changes to the 2013 update. Additions were numerous, showing a high level of skill and interest in the study and its success. IPM experts noted the potential usefulness of the intuitive step-wise approach followed in the crop-pest-IPM-pesticide matrix (Annex 1).

During 2013, USAID's Democracy, Conflict and Humanitarian Assistance (DCHA) Bureau produced a Programmatic Environmental Assessment (PEA) for risk mitigation with fumigation of grain/food warehouses and shipping containers. The advice in this Fumigation PEA replaces warehouse fumigation advice contained in the 2011 U-PERSUAP and 2013 U-PERSUAP Update with more detailed analysis and a cost comparison of alternative tools to aluminum phosphide.

IEEs from several sectors—especially the agriculture, food security and health sectors—now mention the 2011 U-PERSUAP as the most updated source of guidance for pesticide use on USAID projects. However, IEEs in the construction sector could also contain reference to the PERSUAP for termite treatments on construction sites.

Some IEEs mention wood treatment, perhaps telephone poles, fence poles or furniture, which can be risky, and could well be a potential topic for study in the next (2015) iteration of the PPERSUAP in a year or so.

# PERSUAP FINDINGS THAT INDICATE RISKS FROM PESTICIDES

For this study, it was assumed that in order for project field staff and beneficiaries using USAID resources to properly, safely and correctly provide advice to cooperating farmers during demonstrations and training, at a minimum they must understand:

- Primary pests impacting each project-supported sector, activity or crop
- Integrated Pest Management (IPM) tools and tactics used to prevent primary pests of project-supported activities and crops
- Pesticides that can be used for each primary pest of a given sector

- USA and Pakistan pesticide registrations
- Risk issues like acute and chronic toxicities with commonly-used pesticides
- PPE (Personal Protection Equipment) recommended for specific pesticide uses

Field visits and interviews by a contracted local Pakistani pesticide expert showed that not all of the above assumptions hold for most Pakistanis. The expert did field visits to various sectors in Pakistan that could receive USAID support, and interviewed the Government of Pakistan officials, farm stores that sell seeds, pesticides, fertilizers and farm tools, and potential cooperating beneficiaries who will require inputs through local pesticide distributors. Most farm stores were well organized, as recommended, with pesticides separated by use type (insecticide, fungicide and herbicide).

Generally, with the exception of the malaria and Highly Pathogenic Avian Influenza sectors, scarce quantities of PPE are likely to be found, or used. Most pesticide users including small- and medium-scale farmers rarely use PPE other than boots, long pants, a shirt and a hat, and therefore many farm stores do not stock gloves, respirators, and goggles. Respirator masks that were encountered in farm stores contained sponge filters, which stop dusts and some mists, but not volatile organic vapors. The best masks for protection from pesticide vapors contain carbon filter media.

Training is also significantly lacking. Beyond recommending and procuring PPE, Pakistani Implementing Partners, demonstration farmers and other beneficiaries will need to be trained in useful IPM tools and tactics as well as pesticide safe use best practices. Furthermore, highly toxic pesticides (Class I) are found in the region, and in Pakistan.

Results from the 2014 analyses of Pakistan registered pesticide active ingredients are provided below, with discrete, stand-alone lists of those unrestricted for procurement and use and those that may be procured and used with special conditions. Those rejected for procurement and use on USAID projects or by USAID project beneficiaries are included in Section 3, the PER, under Factor a.

# PRIMARY RESULTS OF ANALYSES OF PAKISTAN-REGISTERED PESTICIDES

USAID/Pakistan requested an analysis of pesticides registered for same or similar use in Pakistan. In Annex 7, this PERSUAP analyzes the active ingredients in each of those pesticides. The following lists summarize pesticide recommendations and findings of the Pesticide Evaluation Report (PER) analyses and the Safe Use Action Plan (SUAP). Section 3 of the PER, under 'Factor a' analysis, contains tables of all pesticide AIs rejected by these analyses. Below are the Pakistan registered and recommended ones with just label instructions (green headers) and the registered and recommended ones with other specific conditions (yellow headers).

**TABLE 1: INSECTICIDES (KILL INSECTS) 2014 PERSUAP ANALYSES FINDINGS**

| **Insecticide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID Projects,** with condition that *label instructions* be followed |
|---|
| • acephate<br>• amitraz<br>• azadirachtin/neem tree seed extract<br>• buprofezin<br>• carbaryl<br>• chlorantraniliprole/rynaxypyr<br>• chlorfenapyr |

- clofentezine
- dimethoate
- esfenvalerate
- ethofenprox
- fenitrothion
- hexaflumuron
- indoxacarb, S isomer
- lufenuron
- malathion
- methoprene
- methoxyfenozide
- parafin oil
- permethrin
- pymetrozine
- pyridaben
- pyriproxyfen
- spinetoram
- spinosad
- spiromesifen
- spirotetramat
- tebufenozide
- tralomethrin
- trichlorfon

**Insecticide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects (*with specific conditions; see same or similar uses, with conditions, in Annex 1*)**

- abamectin (use formulations below 1.9%, most formulations below 1.9% are General Use Products (GUP)[1], and above 1.9% are Restricted Use Products (RUP)
- acetamiprid (recommended for use during vegetative growth, not during flowering to protect foraging honeybees)
- beta cyfluthrin (use formulations 10% and below, most formulations below 10% are GUP, and above 10% are RUP)
- beta cypermethrin (use all formulations except 2.5EC, which are RUP)
- bifenthrin (use only 10% EC and 2.5% ULV formulations which are GUP, all other formulations are RUP)
- deltamethrin (GUP for all uses, except on cotton, which in USA are RUP)
- diazinon (for use in cattle ear tags which are GUP; not for agricultural spraying uses, which are RUP)
- diflubenzuron (use formulations less than 25%, most formulations below 25% are GUP, and above 25% are RUP)
- fipronil (registered USA for GUP on termites, ticks, mites, fleas, ants, roaches and mole crickets; expensive ornamental and turf RUP uses unlikely in Pakistan)
- gamma cyhalothrin (modern GUP CS—Capsule Suspension formulation available in Pakistan adds safety; other older non CS formulations in USA are RUP)
- imidacloprid (recommended for use during vegetative growth, not flowering) , not during flowering to protect foraging honeybees)

[1] GUP Pesticides for use by general public and non-certified farmers

| |
|---|
| • lambda cyhalothrin (GUP formulations 10% and below, most formulations below 10% are GUP, and above 10% are RUP).<br>• thiacloprid (recommended for use during vegetative growth, not during flowering to protect foraging honeybees)<br>• thiamethoxam (recommended for use during vegetative growth, not during flowering to protect foraging honeybees) |

### TABLE 2: ACARICIDES/MITICIDES (KILL MITES AND TICKS) 2014 PERSUAP ANALYSES FINDINGS

| **Acaricide/Miticide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects,** with condition that *label instructions* be followed |
|---|
| • dicofol<br>• fenazaquin<br>• fenpyroximate<br>• hexythiazox<br>• spirodiclofen |

| **Acaricide/Miticide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects (*with conditions; see same or similar uses, with conditions, in Annex 1*)** |
|---|
| • abamectin (use only formulations at or below 1.9%, most formulations below 1.9% are GUP and above 1.9% are RUP) |

### TABLE 3: MOLLUSCICIDES (KILL SLUGS AND SNAILS) 2014 PERSUAP ANALYSES FINDINGS

| **Molluscicides AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects,** with condition that *label instructions* be followed |
|---|
| • iron (ferric) phosphate<br>• metaldehyde |

### TABLE 4: RODENTICIDES (KILL RATS, MICE AND VOLES) 2014 PERSUAP ANALYSES FINDINGS

| **Rodenticides AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects,** with condition that *label instructions* be followed |
|---|
| • bromadiolone |

## TABLE 5: FUNGICIDES (KILL FUNGAL DISEASES) 2014 PERSUAP ANALYSES FINDINGS

| **Fungicides AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects,** with condition that *label instructions* be followed |
|---|
| • azoxystrobin<br>• carbendazim<br>• chlorothalonil<br>• copper ammonium carbonate<br>• copper oxychloride<br>• cymoxanil<br>• cyproconazole<br>• difenoconazole<br>• dimethomorph<br>• fluazinam<br>• fludioxonil<br>• fosetyl aluminum<br>• hymexazol<br>• iprodione<br>• kresoxym-methyl<br>• mancozeb<br>• mandipropamid<br>• mefenoxam (metalaxyl-M)<br>• metiram<br>• myclobutanil<br>• propamocarb hydrochloride<br>• propiconazole<br>• pyraclostrobin<br>• pyrimethanil<br>• quintozene/PCNB<br>• streptomycin sulfate<br>• sulfur (sulphur, hydrogen sulfide)<br>• tebuconazole<br>• thiabendazole<br>• thiophanate methyl<br>• thiram<br>• triadimefon<br>• trifloxystrobin<br>• triflumizole<br>• triticonazole |

| **Fungicides AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects (*with conditions; see same or similar uses, with conditions, in Annex 1*)** |
|---|
| • captan (known carcinogen *at repeated high dose uses* over time; PPE essential with repeated use) |

| |
|---|
| • copper hydroxide (use only Class II and III products, not Class I)<br>• triadimenol (EPA use on sorghum canceled—do not use on sorghum; other uses permitted) |

## TABLE 6: HERBICIDES (KILL WEEDS) & PLANT GROWTH REGULATORS (PGR) ANALYSES FINDINGS

| **Herbicides & PGR AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects,** with condition that *label instructions* be followed |
|---|
| • 2 4 D sodium salt<br>• ametryne<br>• aminopyralid triisopropanol-NH3<br>• bensulfuron methyl<br>• bispyribac-sodium<br>• bromoxynil<br>• carfentrazone ethyl<br>• chlorsulfuron<br>• clethodim<br>• clodinafop-propargyl<br>• clomazone<br>• clopyralid<br>• cyhalofop-butyl<br>• dicamba<br>• diquat (dibromide)<br>• florasulam<br>• fluazifop-P-butyl<br>• flucarbazone sodium<br>• fluometuron<br>• fluroxypyr<br>• fluroxypyr methylheptyl ester<br>• formasulfuron<br>• glufosinate ammonium<br>• glyphosate, isopropylamine salt<br>• imazapic<br>• imazethapyr<br>• iodosulfuron-methyl NaCl<br>• linuron<br>• MCPA<br>• mesosulfuron-methyl<br>• mesotrione<br>• metribuzin<br>• nicosulfuron<br>• orthosulfamuron<br>• oxadiazon<br>• oxyfluorfen<br>• pendimethalin |

| |
|---|
| • penoxysulam<br>• pinoxaden<br>• prometryn<br>• quinclorac<br>• sulfentrazone<br>• sulfosulfuron<br>• terbuthylazine<br>• thifensulfuron-methyl<br>• tralkoxydim<br>• triasulfuron<br>• tribenuron methyl<br>• trifloxysulfuron sodium<br>• trifluralin |

| **Herbicides AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects (*with specific conditions; see same or similar uses, with conditions, in Annex 1*)** |
|---|
| • 2 4 D dimethylamine salt (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• acifluorfen, sodium salt (potential carcinogen at high doses, PPE essential with repeated use)<br>• butralin (use only acute toxicity Class III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• ethalfluralin (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• fenoxaprop-P-ethyl (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• fomesafen (use only acute toxicity Class III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• flumetralin PGR (use only acute toxicity Class III products; not Class I products which are too toxic for small-scale farmers who will not use PPE )<br>• glyphosate (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• lactofen (use only acute toxicity Class III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• pyroxsulam (use formulations of 4.5% and lower, most formulations below 4.5% are GUP and above 4.5% are RUP)<br>• quizalfop-p-ethyl (use only acute toxicity Class III products; not Class I products which are too toxic for small-scale farmers who will not use PPE) |

## TABLE 7: MICROBICIDES (KILL MICROBES) ANALYSES FINDINGS

| **Microbicide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects,** with condition that *label instructions* be followed |
|---|
| • bromine |

| |
|---|
| • chlorine dioxide<br>• phenol |

| **Microbiocide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects (*with strict conditions; see same or similar uses, with conditions, in Annex 1* )** |
|---|
| • copper (use only acute toxicity Classes II and III products; not Class I which are too toxic for small-scale farmers who will not use PPE)<br>• hydrogen peroxide (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• iodine (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE)<br>• sodium hypochlorite (use only acute toxicity Classes II and III products; not Class I products which are too toxic for small-scale farmers who will not use PPE) |

**TABLE 8: FUMIGANTS (KILL EVERYTHING IN SOIL & WAREHOUSES) ANALYSES FINDINGS**

| **Fumigant AI in products registered by Pakistan, and Recommended by this PERSUAP for BEO approval and use on USAID projects (*with strict conditions—only certified fumigators may use these fumigant chemicals with USAID assistance*)** |
|---|
| • aluminum phosphide for stored grain pests (for use only by trained and certified applicators, *not smallholder farmers*; see 2013 USAID Fumigation PEA and Annex 14)<br>• magnesium phosphide for stored grain pests (for use only by trained and certified applicators, *not smallholder farmers*; see 2013 USAID Fumigation PEA and Annex 14) |

## Update the Report Annually and Amend the Report in Two Years

New pesticides and EPA registrations change weekly. Furthermore Pakistan updates its list of registered pesticides annually, adding and removing pesticides with each iteration. In addition, new human health and environmental data is produced continuously. For these reasons, and others, this PERSUAP should be updated at least annually, and amended after two years in order to remain current and accurate.

# PERSUAP RECOMMENDATIONS FOR USAID-SUPPORTED PROJECT IMPLEMENTERS TO MITIGATE RISKS

The following are four categories of actions in order of priority, with highest priority actions listed first.

| Immediate Actions Recommended for Implementer and Beneficiary Safety |
|---|
| All USAID project implementers and beneficiaries that use or procure pesticides with project assistance perform IPM and Safe Pesticide Use training (on two or more occasions to ensure sustainability, see Annex 10). |
| All USAID project implementers and beneficiaries that use or procure pesticides with project assistance obtain |

| Immediate Actions Recommended for Implementer and Beneficiary Safety |
| --- |
| recommended PPE (see PPE websites referred and linked to herein). |
| All USAID projects ensure that implementers and beneficiaries do not promote, procure or use, with USAID assistance on USAID projects, pesticides containing the Active Ingredients listed above under 'rejected for use' and shaded in red in Annex 7; perform EDD (Environmental Due Diligence) and provide training and recommendations for avoiding any use of such pesticides; perform EDD and require that assisted enterprises show progress in complying with Pakistan law as a condition for receiving project assistance other than training. |
| All USAID projects use the above 3 lists of pesticide Active Ingredients to match with pesticide Commercial Product Names provided by Ministry of Food, Agriculture and Livestock (MINFAL), and distribute these lists to each Pakistan assistance project implementer. |
| All USAID projects make efforts to obtain, as available, copies of the Material Safety Data Sheets (MSDS) for each of the pesticide products promoted to or used by beneficiaries on Pakistan assistance projects. See MSDSs at: http://www.bayercropscience.com.au/resources/uploads/msds/file7219.pdf. |
| Translate into a local language the most critical PERSUAP sections and Annexes for a more efficient use of PERSUAP findings. |

| Actions Recommended by June 2014 |
| --- |
| USAID projects work with the Pakistani MINFAL to make provisional PMPs for each Project crop (use Annexes 1, 2 and 3 as well as local farmer knowledge) so managers and farmers have a tool to predict, prevent and manage pests throughout the season (see PMPs at http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html, website under crops with a checkmark for "Year-Round IPM Programs"). |

| Continuous Actions Recommended for Safety and BMPs |
| --- |
| USAID projects implementers do hands-on and workshop training that encourages project-assisted farmers to use PPE, pesticide safety best practices and apply pesticides only during the appropriate times of day (early morning/late afternoon, low wind, no rain). |
| Once Government of Pakistan begins to register pesticides anew, USAID projects check the list of registered pesticides every 6 months to obtain new pesticide registrations & regulatory changes. |
| As Pakistan registers them, or they become available, and when the use of pesticides is required to achieve project goals, USAID projects implementers promote commercially available pesticides containing natural chemicals listed in Annexes 4 and 5. |
| For all demonstrations, USAID projects implementers introduce pesticide record-keeping concepts and tools following GlobalGAP or other internationally accepted BMP procedures. |

| Program Management Actions on Compliance |
| --- |
| USAID projects monitor beneficiary farmers for their understanding and use of best practices found in the field form in Annex 11. |
| USAID projects report on monitoring in Annual Reports to USAID COTR and MEO, under a heading titled "Environmental Mitigation and Monitoring". |
| Pakistan assistance projects implementers report on any changes in Pakistan pesticide regulations and registrations. |
| Annually participate in the amending of this PERSUAP to contain new IPM/Integrated Vector Management (IVM) tactics and any new pesticides registered or available. |
| USAID projects write the names of pesticides that cannot be used with USAID assistance into any future grant |

| Program Management Actions on Compliance |
| --- |
| or sub-contract. |
| USAID projects environmental staff members include relevant actions drawn from this SUAP in EMMPRs or draft an EMMPR containing pesticide issues identified in the SUAP, with ways to mitigate the most common risks. |
| USAID amend all contracts/awards to make reference to this new 2014 PPERSUAP.  This may be in a form of a Memo from OAA director to all relevant implementers forwarding this 2014 PPERSUAP. |
| Share with other donors this 2014 PPERSUAP and Section 2.5, Pakistan Pesticide Sector Risks. |

# SECTION 1: INTRODUCTION

## 1.1 Purpose, Scope & Orientation

### Purpose

In compliance with USAID's Pesticide Procedures (22 CFR 216.3(b)), this 2014 Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP) for the USAID projects:

- **Establishes the subset of pesticides (of those registered by Pakistan) authorized for 'procurement or use'** (including indirect procurement[2]) on USAID projects project and activities.

- **Establishes requirements associated with support for these pesticides to** assure that pesticide use/support (1) embodies the principles of safe pesticide use and, (2) per USAID policy, is within an Integrated Pest Management (IPM) framework.

These requirements come into effect upon approval of the PERSUAP.

### Scope

This PERSUAP covers only USAID Pakistan programs/projects/activities, their sub-grantees/partners and beneficiaries.

### Orientation

The set of authorized pesticides and requirements for safe use are established through Section 3 of the document, the Pesticide Evaluation Report (PER), which assesses the 12 pesticide risk evaluation factors (a through l) required by 22 CFR 216.3(b).

The Safe Use Action Plan in Section 4 provides a succinct, stand-alone statement of compliance requirements, synthesized from the 12-factor analysis. It also provides a template for assigning responsibilities and timelines for implementation of these requirements, very similar to the way an Environmental Mitigation and Monitoring Plan (EMMP) would. In fact, the SUAP is adapted into an EMMP at the end of this PERSUAP document. AACL will be responsible for filling the parts of the EMMP that require human and financial resources, as they are most familiar with these and their availability.

## 1.2 USAID Environmental Regulations Development

From 1974 to 1976, over 2,800 Pakistan malaria spray personnel were poisoned (5 to death) by insecticide mishaps on a USAID/World Health Organization (WHO) anti-malaria program[3]. In response to this and other incidents arising from USAID programs, a lawsuit was brought by a coalition of environmental groups for USAID's lack of environmental procedures for overseas projects. USAID, in response to the lawsuit, drafted 22 CFR 216 (Reg. 216). This regulation, which was updated in 1979 to include extraterritorial affairs in response to changes in the scope of the application of the National Environmental Policy Act (NEPA), now guides most USAID activities that could have potentially

[2] Indirect procurement may be the following: Through sub-grantees, financial instruments, partners or contained as a seed treatment on purchased seed.
[3] http://www.ncbi.nlm.nih.gov/pubmed/74508

negative environmental impacts. In effect, the same rules that protect Americans now protect international development partner country's citizens.

## 1.3 22 CFR 216.3(b) (Regulation 216)

According to Regulation 216, all USAID activities are subject to analysis and evaluation via – at minimum – an Initial Environmental Examination (IEE), and – at maximum – an EA. One IEE was written in 2013 to cover economic growth and agriculture. It discusses a PERSUAP for reducing risks with use of pesticides in agriculture. This 2014 USAID projects PERSUAP responds to that IEE recommendation.

A large part of Regulation 216 – part 216.3 – is devoted to pesticide use and safety. Part 216.3 requires that if USAID is to provide support for the use of pesticides in a project, 12 pesticide factors must be analyzed and recommendations be written to mitigate risks to human health and environmental resources. This analysis must be followed up with appropriate mitigation, such as training, monitoring and reporting for continuous improvement on risk reduction and as part of mitigation, adoption of international best practices for crop production, protection measures, and pesticide use safety are strongly encouraged.

### Pesticide Definition

For the purposes of this PERSUAP, the word *pesticide* is used, following EPA's guidelines[4], for the following: fumigants, insecticides, miticides/acaricides, nematicides, molluscicides, fungicides, antimicrobials, bactericides/biocides, microbicides/antibiotics, herbicides, rodenticides, avicides, algicides, ovicides (kill eggs), disinfectants/sanitizers and anti-fouling agents. Even biological agents such as biopesticides, microbial pesticides, repellents, attractants/pheromones, defoliants, dessicants and insect growth regulators are included as pesticides.

### USAID projects/Sub-grantees/Partners Support for Pesticide Use

"Support for pesticide use" by the USAID projects Project was defined and agreed upon at the outset of this PERSUAP study as including:

- Obtaining pesticides through financing, purchase or subsidization.
- Use by USAID Pakistan projects, sub-grantees or farmers on demonstration farms,
- Promotion/recommendation or use during USAID projects and sub-grantee project training of farmers or other beneficiaries.

Pesticides *rejected* by this PERSUAP analysis cannot be 'supported or used' by USAID projects/Partners for any of the above project activities, unless an EA is performed.

## 1.4 The Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP)

In the late 1990s, a USAID Bureau for Africa, East Africa Regional staff member along with a consultant developed the Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP) concept as a tool to analyze the pesticide system or sector in any given country or territory. The PERSUAP tool focuses on the particular circumstances, crops, pests and IPM/pesticide choices of a project or program. This approach analyzes the pesticide sector or system from registration to procurement through use to disposal, and develops a location-specific pesticide risk profile based on the analysis. A PERSUAP is generally

[4] http://www.epa.gov/pesticides/about/types.htm

recommended by and submitted as an amendment to the project IEE or an EA.

Lists of Prior Pakistan IEEs, EAs & PERSUAPs are included in this PERSUAP as Annex 14.

## 1.5 Integrated Pest Management—USAID Policy

In the early 1990s, USAID adopted the philosophy and practice of Integrated Pest Management (IPM) as official policy. IPM is also strongly promoted and required as part of Regulation 216.3. Since the early 2000s, IPM—which includes judicious use of 'safe' pesticides—has been an integral part of Good Agriculture Practices, including GlobalGAP, and is increasingly considered to constitute best management practices in agriculture.

A good definition of IPM from UC-Davis[5] follows:

> "Integrated pest management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials [pesticides] are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment."

Another good definition of IPM from OECD[6] follows:

> "Integrated pest management (IPM) is an approach to the management and control of agricultural pests which relies on site- and condition-specific information to manage pest populations below a level that causes economic injury and that minimizes risks to humans and the natural environment.
>
> Although any among a wide range of pest control agents may be used (including chemical sprays), IPM generally stresses the use of alternatives, such as crop rotations, mechanical cultivation, and biological agents, where such methods are deemed to be effective."

The history of IPM and Food Safety in Pakistan is recorded in this PERSUAP in Annex 15.

## 1.6 Pakistan PERSUAP Methodology and Scope of Work

During planning for this study, a decision was made to use one local Pakistani National Pesticide Expert (PNPE) and one Expatriate Pesticide Expert (EPE), who would both collect and analyze information from Pakistan's pesticide use sectors. The largest tasks would be the analysis, for Regulation 216 compliance, of the active ingredients in each pesticide registered as of 2014 by Pakistan for import and use, as well as the analysis of primary pests in each sector and of each crop or livestock, so that preventive IPM plans could be made. The SOW for this 2014 Pakistan PPERSUAP is attached as Annex 13.

From February to April of 2014, the PNPE in Pakistan contacted, emailed, phoned, visited and interviewed government officials, private sector, NGOs, bilateral and multilateral donors and some USAID projects and their beneficiaries. Questions were posed by phone, email and in person about the

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[5] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[6] http://stats.oecd.org/glossary/detail.asp?ID=1379

continuing usefulness of the 2011/2013 U-PERSUAP/Update, ways to improve it and changes that have occurred since 2013 in terms of new pesticide registrations, new crops, pests and IPM tools. The PNPE also collected information on how the IPM system in Pakistan has changed and improved as well as food safety and trade issues.

The EPE sent questions to the PNPE and a questionnaire to USAID for current projects to fill, analyzed 269 pesticides registered by Pakistan as of 2014, analyzed for preventive IPM tools and pesticides the pests of 5 new crops/produce in 2014, as follow:

### Six new crops/produce for 2014 (See Annex 1)

- Mushrooms
- Currants
- Persimmons
- Bay leaf
- Sea Buckthorn
- Honeybee Products

The EPE researched and analyzed lists of 196 new pesticides and newly labeled uses of pesticides registered for 2013/2014 and the PNPE visited pesticide stores to inventory what was present and to collect information on pesticide shop safety. A copy of these lists is attached as Annex 16. New pesticide active ingredients registered for procurement and use in Pakistan for 2014 follow (note that these were analyzed and that ***not all of these were accepted for use on USAID projects***, see Annex 7):

### New insecticide active ingredients for 2014

- chlorfluazuron
- chlothianidin

### New fungicide active ingredients for 2014

- copper hydroxide
- fluazinam
- thiram seed treatment

### New herbicide active ingredients for 2014

- 2 4 D as a sodium salt
- alachlor
- fluroxypyr
- formasulfuron
- glyphosate as isopropylamine salt
- metsulfuron
- terbuthylazine
- terbutryne
- triasulfuron
- tribenuron methyl

# SECTION 2: BACKGROUND

## 2.1 Pakistan Country Background

Pakistan is a Southern Asian country of about 779,000 square kilometers, and almost 165 million people, bordering the Arabian Sea, sandwiched between India on the east, China on the north and Iran and Afghanistan on the west. See Map (Figure 1) below of Pakistan and its neighbors.

**FIGURE 1: MAP OF PAKISTAN**


Pakistan is composed of flat Indus plains in east; mountains in north and along the northwest border with Afghanistan; the Balochistan plateau in west, and with the Indus River flowing directly through the middle of the country from north to south. The climate is mostly hot, dry desert; temperate in northwest; arctic in mountainous north.

The Indus Valley civilization, one of the oldest in the world and dating back at least 5,000 years, spread over much of what is presently Pakistan. During the second millennium B.C., remnants of this culture fused with the migrating Indo-Aryan peoples. The area underwent successive invasions in subsequent centuries from the Persians, Greeks, Scythians, Arabs (who brought Islam), Afghans, and Turks.

### International Trade

Pakistan trade includes: *Exports*--$14.85 billion: textiles (garments, bed linen, cotton cloth, and yarn), rice, leather goods, sports goods, carpets, rugs, chemicals & manufactures. *Major partners*--U.S. 22.6%, United Arab Emirates 8.9%, U.K. 5.8%, China 5.4%, Germany 4.7%. *Imports*--$21.26 billion: petroleum, petroleum products, machinery, plastics, paper and paper board, transportation equipment, edible oils, pulses, iron and steel, tea. *Major partners*--China 14.0%, Saudi Arabia 10.5%, United Arab Emirates 9.0%, Japan 6.2%, U.S. 5.1%, Kuwait 5.1%, Germany 4.9%. Pakistan exports textiles (garments, bed linen, cotton cloth, and yarn), rice, leather goods, sports goods, chemicals, manufactures, carpets and rugs. Major export partners as of 2005 are US 24.8%, UAE 7.8%, Afghanistan 6.6%, UK 5.7%, Germany 4.5%.

### Fiscal Policy

International Monetary Fund (IMF)-approved government policies, bolstered by generous foreign assistance and renewed access to global markets since 2001, have generated solid macroeconomic recovery the last five years. The government has made substantial macroeconomic reforms since 2000, most notably privatizing the banking sector. Poverty levels have decreased by 10% since 2001, and Islamabad has steadily raised development spending in recent years, including a 52% real increase in the budget allocation for development in FY07, a necessary step toward reversing the broad underdevelopment of its social sector.

The fiscal deficit - the result of chronically low tax collection and increased spending, including reconstruction costs from the October 2005 earthquake - appears manageable for now. GDP growth, spurred by gains in the industrial and service sectors, remained in the 6-8% range in 2004-06. Inflation remains the biggest threat to the economy, jumping to more than 9% in 2005 before easing to 7.9% in 2006. The central bank is pursuing tighter monetary policy - raising interest rates in 2006 - while trying to preserve growth. Foreign exchange reserves are bolstered by steady worker remittances, but a growing current account deficit - driven by a widening trade gap as import growth outstrips export expansion - could draw down reserves and dampen GDP growth in the medium term. In 2011, the GOP was faced with a deteriorating economy as foreign exchange reserves decline, the currency depreciates, and the current account deficit widens. In 2014, according to the World Bank, economic growth recovery was well underway.

## Agricultural and Natural Resources

Agriculture in Pakistan dates back to Neolithic times. It formed the base of the well-known Indus Valley Civilization. Its contribution to the Gross Domestic Product (GDP) has decreased from 52% in 1950-51 to just 24% in 1993-94, and lowers in the 2000s. This is primarily because of higher growth rates registered by other sectors, particularly, the Manufacturing and Mining.

Pakistan is a land of subsistence agriculture. The main emphasis is on the production of food crops that account for about 70% of the cropped area. Some cash crops (cotton, sugarcane, tobacco, for instance) are grown to meet other needs. About 23% of the total land area is cultivated. Still, the cropped area has increased from 14.6 million hectares in 1947-48 to about 22.15 million hectares in 1993-94: a hefty increase of about 52%.

Pakistan's principal natural resources are arable land, water, hydroelectric potential, and natural gas reserves. About 28% of Pakistan's total land area is under cultivation and is watered by one of the largest irrigation systems in the world. Agriculture accounts for about 21% of GDP and employs about 42% of the labor force. The most important crops are cotton, wheat, rice, sugarcane, fruits, and vegetables, which together account for more than 75% of the value of total crop output. Despite intensive farming practices, Pakistan remains a net food importer. Pakistan exports rice, fish, fruits, and vegetables and imports vegetable oil, wheat, cotton (net importer), pulses, and consumer foods.

The economic importance of agriculture has declined since independence, when its share of GDP was around 53%. Following the poor harvest of 1993, the government introduced agriculture assistance policies, including increased support prices for many agricultural commodities and expanded availability of agricultural credit. From 1993 to 1997, real growth in the agricultural sector averaged 5.7% but declined to less than 3% in 2005. Agricultural reforms, including increased wheat and oilseed production, play a central role in the government's economic reform package. Heavy rains in 2005 provided the benefit of larger than average cotton, wheat, and rice crops, but also caused damage due to flooding and avalanches. Since then crop yields have fluctuated annually.

Pakistan has extensive energy resources, including fairly sizable natural gas reserves, some proven oil reserves, coal, and large hydropower potential. However, exploitation of energy resources has been slow due to a shortage of capital and domestic and international political constraints. For instance, domestic gas and petroleum production totals only about half the country’s energy needs, and dependence on imported oil contribute to Pakistan's persistent trade deficits and shortage of foreign exchange. The government announced that privatization in the oil and gas sector is a priority.”

## 2.2 Donor-Supported Agriculture Sectors with Potential Pesticide Procurement and Use in Pakistan

In addition to USAID and donor-funded initiatives in agriculture and IPM, namely Improving Livelihoods and Enterprise Development Program (I-LED), FATA-LDP, British Commonwealth Agriculture Bureau International (CABI) Bioscience Pakistan Centre, UN Food and Agriculture Organization (FAO) Farmer Field Schools (FFS), Asian Development Bank (ADB) Training of Trainers (TOT) and Training of Facilitators (TOF), National IPM (NAT-IPM) Programme, FAO-ADB Cotton IPM, FAO- Arab Gulf Program for Development (AGFUND) pilot project, FAO-EU IPM Project, Commonwealth Institute of Biological Control (CIBC), other relevant projects include the following.

### USAID

Listed in Annex 14 titled: Prior USAID Pakistan IEEs, EAs, PERSUAPs

### UNFAO

In 2002, FAO revised its original 1985 version of the International Code of Conduct on Distribution and Use of Pesticides[7]. This 2003 Code and previous iterations have guided the production of national pesticide regulations around the world, including in Pakistan. In 2007, FAO, along with WHO, formed the Joint Meeting on Pesticide Management (JMPM). Each year they meet to make decisions on pesticide issues like legislation, policy, registration, compliance, distribution, and use and application equipment, among others[8]. These JMPM decisions have been used over the past 4 years up to 2013 to guide pesticide regulation decisions in Pakistan.

Furthermore, FAO's FFSs have been and continue to be key to guiding Pakistani farmers' development and adoption of IPM tools and tactics. The use of preventive IPM reduces the need for large applications of pesticides.

2013-2016 Government Cooperative Programme (GCP)/PAK/127/USA: Control of Transboundary Animal Diseases in Pakistan "Progressive Control of Peste Des Petits Ruminants (PPR) in Pakistan"

2013-2014 GCP/PAK/125/USA: Building Provincial Capacity in Pakistan for Crop Forecasting and Estimation

2010-2015 GCP/PAK/123/USA: Support to Increase Sustainable Livestock Production. Support to Increase Sustainable Livestock Production

2009-2015 GCP/PAK/USA: United States Assistance to Agricultural Development in Balochistan Border Areas (USABBA)

2009-2013 OSRO/RAS/901/EC: Improvement of regional capacities for the prevention, control and eradication of highly pathogenic and emerging diseases (HPED) including Highly Pathogenic Avian Influenza (HPAI) in Association of Southeast Asian Nations (ASEAN) and South Asian Association for Regional Cooperation (SAARC) countries: Regional Project - 18 participating countries including Pakistan. To strengthen and empower ASEAN and SAARC, in their ability to prevent, control and eradicate HPED, including HPAI, through improved veterinary and public health services and inter-sectoral collaboration on a regional basis

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7 http://www.fao.org/docrep/005/y4544e/y4544e00.htm
8 http://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/code/list-guide-new/en/

## United Nations Environment Program (UNEP)

UNEP's Chemicals Branch, working with FAO, has produced guidelines[9] for tracking DDT use[10] as well as for finding alternatives to POP chemicals for control of termites[11]. These guidelines also include diagnosis and treatment of pesticide poisoning and childhood pesticide poisoning. These guidelines have been distributed and are currently being used to inform decisions in Pakistan.

## UN World Food Program (WFP)

WFP has developed guidelines and standard operating procedures for the use of chemicals (aluminum phosphide and magnesium phosphide) that produce phosphine gas for warehouse fumigation[12]. These guidelines have assisted Pakistan in its emergency food receipt programs, so that only certified fumigators use highly toxic fumigants. The also produce guidelines for safe rodent IPM and control.

2014: Enhancing Food and Nutrition Security and Rebuilding Social Cohesion, Protracted Relief and Recovery Operations (PRRO) funding

January 2011 – December 2012: Protracted Relief and Recovery Operation: Food Assistance for Household Food Security, Early Recovery, Peace and Social Stability

Worsening food security has been most pronounced in marginalized areas along Pakistan's western border, which have been subject to conflict and mass displacement in recent years. Targeting up to 9.5 million beneficiaries during 2011 and 2012, this operation draws upon the full range of tools in UN World Food Program's (WFP) arsenal, in order to best respond to immediate food needs, support recovery from multiple shocks and contribute to social cohesion. These include the provision of emergency relief rations to conflict-affected groups who remain displaced or have recently returned home in Khyber Pakthunkhwa (KPK) and FATA; school feeding to promote access to education; nutritional support measures for children and women; livelihood recovery activities through community-based employment using food and/or cash; and measures aimed at developing institutional and local capacities in disaster risk management.

## UN Development Programme (UNDP)

UNDP programs defer to FAO's and UNEP's guidelines and programs on pesticide use. The United Nations Development Programme (UNDP) has been an important partner of the Government of Pakistan throughout 2013 and into 2014 for achieving national development goals and international commitments including the Millennium Development Goals (MDG). UNDP's works with the Government, civil society and development partners in four broad programmatic areas; Poverty Reduction and Gender, Democratic Governance, Environment and Climate Change and Crisis Prevention and Recovery.

2014: Area Development Programme in Balochistan. Continuing into 2014, the Area Development Programme Balochistan project is a community-based development programme co-financed by the Government of Balochistan and United Nations Development Programme. Though phase-II of the project was initiated in July 2006, its field activities started in May 2007.

Oct 2006 -Apr 2012: Community Development Project for Rehabilitation of Salt Affected & Waterlogged Lands (Bio Saline II)

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9 http://www.unep.org/chemicalsandwaste/UNEPsWork/Pesticide-relatedactivitiesatUNEPChemicals/tabid/104444/Default.aspx
10 http://www.chem.unep.ch/ddt/Default.html
11 http://www.chem.unep.ch/termites/Default.html
12 http://foodqualityandsafety.wfp.org/fumigation

The Bio Saline II project aims at developing sustainable farming systems for the rehabilitation of waterlogged and salt affected lands to improve livelihoods in three districts of Punjab, namely Hafizabad, Jhang, and Sargodha. Objectives include: Mobilizing communities to partner with the Government on agriculture and land rehabilitation schemes; Introduction and demonstration of improved agricultural techniques; and Improving access to services and markets.

### UN World Health Organization (WHO)

In addition to working with FAO on its JMPM, WHO has produced a number of guidelines for safe control of disease vectors. WHO has produced guidelines for procuring public health pesticides, and it supports the use of Insecticide Treated Nets (ITN), Long-Lasting Insecticidal Nets (LLIN) as well as the use of DDT and other chemicals for Indoor Residual Spraying (IRS). All of these have been used to reduce the incidence of mosquito bites and malaria in Pakistan.

2014: WHO's Strategic Agenda for 2012-2016: The priorities of WHO strategic agenda are as follows: Health System Strengthening: Health policy and system development including imp roving policy making and governance; human resources for health; improving service delivery, access and equity; achieving equitable and fair health financing; developing public–private sector partnership and regulation of private sector; medical products, vaccines and technology; health information and research; partnerships, as well as resource mobilization and coordination. These serve the following needs:

> Communicable Diseases: Improving immunization; disease control; and improving surveillance.
>
> Non-communicable Diseases: Prevention and control of non-communicable diseases.
>
> Life Courses: Improving maternal, newborn and child health including nutrition and reproductive Health; promotion of healthy environment and living; gender mainstreaming and occupational health.
>
> Emergency Preparedness and Response: Emergency preparedness response of the health sector and disaster risk management

#### 2011: Pakistan Floods Rapid Response Plan

The Pakistan Floods Rapid Response Plan launched on 18 September 2011 covers the financial humanitarian needs for the first months of the relief efforts in Sindh Province. The Health and Nutrition Cluster seeks US$ 45.9 million, including US$ 14.8 million for WHO. The main objectives are to preserve and restore access to basic health care and to prevent, control and respond to communicable disease outbreaks. So far, enough medicines and supplies have been distributed for the provision of health care to 285 000 people for a month. WHO also provided 1040 clean delivery kits, 1550 anti-snake venom kits and 1000 hygiene kits.

#### 2008-2011: Global Roll Back Malaria (RBM)

At present, Pakistan is a member of WHO Global RBM Initiative, with a commitment to intensify its efforts for effective control of malaria in the country. Since its inception in 1948, WHO has been the major technical partner with the Ministry of Health (MOH) in malaria control activities. Currently WHO provides technical and financial support to the RBM Programme for strengthening early diagnosis, prompt and effective treatment and epidemic control and operational research.

#### Objectives of the RBM Programme

1. To reduce malaria morbidity by 50 % by end of the year 2010

2. To reduce malaria mortality to minimum

3. To prevent and control malaria outbreaks

## World Bank Group (WBG, WB)

WBG developed and implements a Pest Management Guidebook[13]. WBG's **Operational Policy 4.09: Pest Management:** Rural development and health sector projects have to avoid using harmful pesticides. A preferred solution is to use Integrated Pest Management (IPM) techniques and encourage their use in the whole of the sectors concerned.

If pesticides have to be used in crop protection or in the fight against vector-borne disease, the Bank-funded project should include a Pest Management Plan (PMP), prepared by the borrower, either as a stand-alone document or as part of an Environmental Assessment.

During 2013, WB's Sindh Agricultural Growth Project has produced an Integrated PMP[14] as is recommended by WB for crop protection projects. Now, a PMP needs to be developed for all of Pakistan. Information in Annex 1 could be used to start this process.

Throughout 2013 and into 2014, the World Bank worked in cooperation with various groups including communities, civil society, government, and donor agencies. The joint effort of these groups is required to significantly reduce poverty. The World Bank provides technical expertise and funding in areas such as health, education, public administration, environmental protection, agriculture, and basic infrastructure.

Working with the government and civil society, the World Bank has developed an action plan known as the Pakistan Country Assistance Strategy which describes *what kind of support* and *how much* could be provided to the country beginning June, 2002 and covering a period two years. The strategy was designed to directly support the government's Poverty Reduction Strategy and focuses on three key areas:

1) strengthening economic stability and government effectiveness;
2) strengthening the investment climate;
3) supporting pro-poor and pro-gender equity policies.

The World Bank Group's strategy and support to Pakistan is currently organized around four pillars: (i) improving economic governance; (ii) improving human development and social protection; (iii) improving infrastructure to support growth; and (iv) improving security and reducing the risk of conflict. Within these pillars, WBG aims for these transformational outcomes:

***Strengthening Tax Policy and Administration***: raising the ratio of tax to GDP (currently only

10.2 percent of GDP) is absolutely essential if Pakistan is to have the resources to invest in human development and infrastructure, and if it is to build resilience to future shocks and guard against costly and disruptive growth reversals.

***Expanding Power Provision***: reforming the power sector and ensuring sustainable expansion of supplies is absolutely essential if industrial and service activity is to be increased and productivity raised.

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[13] http://go.worldbank.org/J0RIVUFLR0
[14] http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/09/25/000442464_20130925110637/Rendered/PDF/E42960v20SINDH000PUBLIC00Box379832B.pdf

***Addressing Security:*** coping with the consequence of conflict while reducing the prospects of future conflict is essential for long-term growth. This is a highly complex area, and the Bank's competence and knowledge is evolving but limited. WBG will, however, make this a major thrust of their work, giving emphasis to service provision and job creation in highly vulnerable areas (and drawing upon emerging findings from the WDR and from work in Pakistan).

## Asian Development Bank

ADB's Country Partnership Strategy (CPS), 2009–2014 planned assistance of $4.4 billion through 2014, and annual average lending of almost $1.5 billion. The CPS provides the framework for ADB's partnership priorities and the future direction of its assistance strategy in Pakistan, and prioritizes the following four areas for ADB's support to Pakistan[15].

- Reforms and investments in key infrastructure sectors include support for power and energy, transport and the National Trade Corridor, and water resources. This assistance will reduce the cost of doing business and strengthen the underlying competitiveness of the economy.
- Reducing distortions, accelerating market creation, and addressing governance and institutional bottlenecks will provide support for a new generation of economic reforms. The government is addressing challenges with the help of financial assistance from partners, including an IMF-backed stabilization program. Institutional reforms to strengthen local fiscal and financial management systems, and a better environment for private sector investments, including through public-private partnerships, are needed.
- Development of urban services through pivotal interventions in Pakistani cities and secondary towns will unleash economic potential, while improving the quality of life of poor urban citizens.
- Effective implementation of projects and programs and capacity building will bring about greater aid effectiveness and sustainable development results.

## German Gesellschaft für Internationale Zusammenarbeit (GIZ)

GIZ supports programs in basic education, health, renewable energy, good governance, and the special FATA Development Program.

### FATA Development Programme

2014: The GIZ FATA Development Program is anchored in the FATA Sustainable Development Plan (2006-2015) and operates in accordance with the Post Crisis Needs Assessment (PCNA). It pursues an integrated approach intended to enhance the credibility of the government by improving services, while also increasing the transparency of planning processes and allowing the population to assert their right to public services. Its many partners and target groups include project managers, staff of hospitals and schools, communities, elders and Jirgas, politicians, civil society representatives, the University of Peshawar, and professional and private provider associations. The programme consists of three components: education, health and livelihoods.

The main objective of the first phase of the livelihood component is to set up accountable community development funds for the implementation of small-scale and short-term projects in cooperation with communities, the local government and administrative agencies. In order to understand properly the environment in which it works, GIZ carries out objective livelihood analyses, context studies and exchanges with local development partners. At the same time the programme offers advice and training to

[15] http://beta.adb.org/countries/pakistan/strategy

the participants in the projects, to enhance their productive potential. Since agriculture is central to the FATA economy, it will be one of the focal points of this program.

### International Center for Research in the Dry Areas (ICARDA)

In general, ICARDA's research is focused on delivering solutions that can help improve the performance of farming systems and people's livelihood the dry areas of the world. ICARDA works toward the improvement of barley, lentil and faba bean worldwide. It serves the non-tropical dry areas for the improvement of on-farm water use efficiency, rangeland and small-ruminant production.

In the Central and West Asia and North Africa region, ICARDA contributes to the improvement of bread and durum wheat varieties, kabuli chickpea, pasture and forage legumes, and associated farming systems.

ICARDA also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of the research outputs.

ICARDA's international cooperation is built on its close relationships with national agricultural research systems (NARS) and other partners. ICARDA has a regional program covering dry, medium- to high-altitude areas in Afghanistan, Iran, Pakistan and Turkey. Many of ICARDA's research results and technologies, especially hybrid varieties of staple crops, reach Pakistan and farmers.

### International Center for Research in Semi-Arid Tropics (ICRISAT)

ICRISAT, a CGIAR center based in Hyderabad, performs the same tasks as its sister institution, ICARDA, above, but on different crops. ICRISAT conducts research on five highly nutritious, drought-tolerant crops – chickpea, pigeon pea, pearl millet, sorghum and groundnut. As with ICARDA, many of ICRISATs research results and technologies, especially new hybrid varieties, reach Pakistan and farmers.

## 2.3 Pesticide Regulations and Import from Neighboring Countries

According to local interviews by the PNPE, few to no pesticides enter Pakistan from Iran, Russia or Central Asian Republics. In fact, many pesticides are produced in Pakistan. While information on exact amounts imported formally and informally from China, India and Afghanistan is not available, these countries serve as major producer and supplier countries to the region, including Pakistan. Quality of these products is an objective measure, only known if the imported products are tested, which they are not.

### China

After the United States, China is the second largest manufacturer of pesticides in the world. Chinese factories and pesticide companies produce the active ingredients for both the top and bottom ends of the sector. Some of the better quality factories now are sub-contracted to produce active ingredients for pesticides in international brand-name companies.

However, many of the rest of the factories and companies flood developing world markets with the most popular chemicals that are easy to make, but may have contaminants or less active ingredient (AI) than advertised. In China, since 1963, the Ministry of Agriculture's Institute for the Control of Agrochemicals of the Ministry of Agriculture (ICAMA) is supposed to regulate the manufacture and sale of agricultural pesticides. Numerous Chinese products, some appearing with pirated international labels, can be found throughout the region. All interviewed for this PERSUAP indicate that product quality of Chinese-made pesticides is in question, but they do not have sufficient resources to analyze these pesticides.

### India

Following the United States and China, India is the third largest producer of pesticides in the world. According to http://www.bharatbook.com/detail.asp?id=53019 "The production of Indian pesticides industry has almost remained stable at 82000-85,000 MT during FY10. Exports formed 55.56% of total industry revenues in FY10 and have grown at a Compounded Annual Growth Rate (CAGR) of 37.59% from FY06 to FY10. Prior to 2005, i.e. in the process patent regime, Indian companies focused on applied research and concentrated on marketing generic and off-patent products. Due to this, the R&D expense by Indian companies was lower at approximately 1% of turnover.

Global [Multi-National Corporations (MNCs)] companies focused on high-end specialty products and dominated the market for patented new molecules. Globally, pesticides companies spend 8-10% of their turnover on R&D. However, with the onset of the product patent regime in India since 2005, the Indian companies will need to increase R&D expense to meet competition from MNCs. Alternatively Indian companies can be competitive in the area of Contract Research And Manufacturing Services (CRAMS). With the advent of the Integrated Pest Management (IPM) technique, the use of biopesticides and Genetically Modified (GM) seeds has increased."

India is one of the most dynamic generic pesticide manufactures in the world with approximately 60 technical grade pesticides being manufactured indigenously by around 125 producers consisting of large and medium scale enterprises (including 10 MNCs) and more than 500 pesticide formulators spread over the country[16]. The Insecticides Act, 1968 and Insecticides Rules, 1971 regulate the import, registration process, manufacture, sale, transport, distribution and use of insecticides (pesticides) with a view to prevent risk to human beings or animals and for all connected matters, throughout India. All pesticides have to necessarily undergo the registration process with the Central Insecticides Board & Registration Committee (CIB & RC) before they can be made available for use or sale.

### Afghanistan

Due to years of conflict and no functional government, Afghanistan still has no approved list of pesticides registered for manufacture, procurement and use up through 2014. To counter the use of sub-standard pesticides entering from China and other countries, donors in Afghanistan are encouraging MAIL, input stores and farmers to procure and use only name-brand pesticides from established international companies. Pesticide exports from Afghanistan importers/distributors to Pakistan are increasing rapidly, accorindg to those interviewed for this PERSUAP.

## 2.4 Potential Pesticide Use Sectors in Pakistan

### Seed Treatment with Pesticides and GMOs

Many USAID agriculture projects donate or assist with acquisition of quality hybrid crop seed for farmers they serve. Almost all of this seed, as well as practically all modern vegetable seeds are treated with pesticides (see the photo below of treated vegetable seeds of every color, from the region).

[16] http://www.indiajuris.com/pest.pdf

Most commercial seed treatment, by volume, is done by the company that produces and packages the seed, and not by donors, and not by farmers.  And almost all treated seed is colored to show that it has been treated—this is so that it is not confused with food grain, not cooked and eaten.

Some farmers in Pakistan save seed from season to season and treat it themselves with at least one of the following pesticide products found available throughout the region: Raxil, Fundazole, Kalfigo Super, Maxim, Vitavax and Vinner.  Generally seed-treatment pesticides are formulated as one of the following: FS = Flowable concentrate for Seed treatment (most seed treatments); DS = Powders for Dry Seed treatment; SC = Suspension Concentrate; WP = Wettable Powder; MD = Micro Dispersion; WS = Water dispersible powder for Slurry treatment.

### Methods of Seed Treatment

**Seed Dressing**: The most common method of seed treatment in which seed is either dressed with a dry formulation or wet treated with a slurry or liquid formulation. Dressings are applied both on-farm or in specialized seed treatment facilities. This is very common among majority of farmers in Pakistan. Farmers dress seed by simply mixing pesticide with seed in simple pot/tub or rotary machine (simple cement mixing) depending upon the size of the farm.

**Seed Coating**: A special binder is used with a formulation to enhance adherence to the seed, which may impact seed size and shape. Coatings require advanced treatment application technology and it is not common in Pakistan.

**Seed Pelleting**: It is the most sophisticated seed treatment technology, which is available in technically advanced countries. It includes changing the physical shape of a seed to enhance plantability and handling. Pelleting requires specialized application machinery and techniques and is the most expensive of the applications. This is not used in Pakistan at any level.

### Seed Treatment in Pakistan

Mostly seed treatments are practiced for cotton, cereals oilseeds, and vegetable crops. However, only a small number of farmers treat their self produced seeds. Seed supplying companies claim to market pre-treated seed. Some of the important seed treatment agrochemicals are noted in Annex 7, column 3 with an "S" for Seed.

### Safety of workers

Proper safety measures are recommended for the workers engaged in seed treatment such as use of gloves, goggles, cap, special clothes and gumboots.  However, these measures are rarely observed anywhere in Pakistan, except use of gloves. Farmers usually use a piece of cloth, a traditional dress (a type of turban) of farming community to cover their head and nose.

### GMOs

Pakistan, in 2001, signed The Cartagena Protocol on Biosafety to the Convention on Biological Diversity[17] and has since (2009) ratified it and entered it into force.  However, to provide biosafety while using GMOs (Genetically Modified Organisms), and the effective use of biotechnologies, the following measures need to be taken: developing legislative and institutional base in this field; training specialists and creating a special body controlling the GMO management; and developing special programs on informing the population of genetically modified organisms.

[17] http://www.cbd.int/countries/contacts.shtml?country=kg; http://bch.cbd.int/protocol/

According to a USDA[18] "In 2012, Pakistan formally approved eight Bt [GMO] and six conventional cotton varieties for general cultivation. While a biotech framework and necessary legislation have been put in place, the government's capacity to evaluate and monitor new biotech crops was put on hold since last year's devolution of key ministries. Implementation of the Plant Breeder's Rights Act and amendments to the Seed Act are still pending in the parliament. Aside from traditional vaccines and some genomic studies there is little Genetically Engineered (GE) animal activity in the country."

"The administration and farmers in Pakistan are generally pro-biotech. In 2012, eight Bt cotton (MON 531) and six conventional (Non Bt) cotton varieties were approved by the Government of Pakistan (GoP) for general cultivation. A number of Genetically Modified (GM) crops are currently under development with public/ private / multinational seed companies in Pakistan. Bt varieties now account for nearly three million hectares of the total cotton area cultivated (8.5 million acres) in Pakistan. All components such as crop co-coordinated trials, biosafety evaluation and Intellectual Property Rights (IPR's) systems are in place."

"The major U.S. agricultural trade interests related to biotechnology in Pakistan at this time are related to cotton, corn, soybeans and animal feed. There are no laws banning the import of biotech products (i.e. bulk agricultural commodities, snack foods and processed items). Pakistan has ratified the Cartagena Protocol of Biosafety (CPB) and maintains a framework of handling Genetically Modified Organisms

(GMO's). International seed companies are actively engaged in meeting greater demand for GM cotton, corn, and canola seeds in the country."

In 2012, USAID funded an International Food Policy Research Institute (IFPRI) study on Bt Cotton Adoption and Wellbeing of Farmers in Pakistan[19]. Recently the USAID-sponsored Agribusiness Support fund (www.agribusiness.org.pk) resulted in the establishment of a banana tissue culture facility at Nizamani farms in Sindh. However, to date, USAID has not directly funded any import or use of known GMO crops.

USAID has Agency Procedures for Safe Use of Genetically Engineered Organisms[20]**.** If a USAID-funded activity will potentially involve the use of genetically modified organisms in research, field trials, or dissemination, the activity must be reviewed and approved for compliance with applicable U.S. requirements by the USAID Biosafety Officer in Washington prior to obligation of funds and prior to the transfer, testing, or release of biotechnology products into the environment. This review and approval is limited to the safety aspects of the proposed activity and may involve external peer review or demonstration of comparable safety oversight by other expert U.S. federal agencies. Therefore, adequate time should be budgeted for this approval process. This biosafety determination is separate from, and precedes and informs, the 22 CFR 216 environmental impact assessment determinations.

### Advantages of Seed Treatments and GMOs

Since they are used at very small amounts of active ingredient per seed and thus per unit of land, and take the chemical directly to the pest, seed treatments with pesticides fit nicely within an IPM program. They exert a much lighter impact on the environment than spraying an entire field. They protect the seed from numerous soil and seed-borne fungal, bacterial and insect pests, so that germination and seedling growth can proceed unimpeded. And, there are some biological seed treatments available and some new ones

[18] http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Agricultural%20Biotechnology%20Annual_Islamabad_Pakistan_7-24-2012.pdf
[19] http://www.ifpri.org/sites/default/files/publications/psspwp4.pdf
[20] http://www.usaid.gov/our_work/environment/compliance/apsugeo.html

being developed. Use of GMO cotton, though relatively expensive, can help reduce the number of pesticide sprays needed[21] to control boll-penetrating moth larvae.

### Risks from Treating Seed with Pesticides On-Farm and GMOs

Treating seed involves many of the same risks as for mixing concentrated pesticide products and applying them to field or greenhouse and nursery crops. First, it assumes that the farmer knows the principle soil diseases and pests present and what to use against them. It also assumes that farmers understand the risks associated with treating, packaging, labeling, storing and planting the seed.

Ideally, seed would be treated in a specialized "seed treater" composed of a mixing tank, treater head and coating chamber to apply precisely measured quantities of pesticide. Proper PPE must be used by the farmer applicator and unused pesticide and residues must be properly disposed of. Next, the treated seed must be properly labeled as "Treated" with the common (Active Ingredient) and trade (Product) names of the pesticide used, health hazards of the pesticide such as skin or eye irritant, or if it is a carcinogen. For highly toxic chemicals, the statement "This seed is treated with a poison" and for toxic chemicals, the statement "Do not use for food, feed or oil purposes" must be used.

Seed treated for planting must be stored separately from grain to be used for food, animal feed or oil extraction. Storage must be in a dry, well-ventilated space. Farmers must keep treated seed out of reach of small children. More BMPs for seed treatment are found on the following website: http://www.ksre.ksu.edu/library/entml2/s18.pdf.

AID implementing partners are effectively limited to promoting or purchasing and donating only seed treatment pesticides or seed already treated with pesticides registered by EPA for same or similar uses. For this reason, this PERSUAP evaluates, in Annex 7, all of the AIs commonly found in seed treatment pesticides for EPA registration, human health and environmental risks, among other factors. Note again that the AIs commonly found in concentrated and formulated seed treatment pesticide products will present more application risks than seed already treated, due to a dilution effect.

Some GMO crops present risks as well as advantages. Risks include the development of pest resistance to the modified crop. So-called "super weeds" have developed from over-use of glyphosate (Roundup) on Roundup Ready soybeans[22]. Risks also include cross-pollination of GMO plants with open pollinated non-GMO crop plants, causing contamination. Further, many useful genes are inserted accompanied by other gene insertion sequences that may be human allergens.

## Field Agriculture Pesticide Procurement[23] and Use

A large number of USAID development projects focus on increasing agricultural production and markets in countries where agriculture still consumes most of a country's labor, natural resources and GDP output. In Pakistan, in particular, several programs have aimed at assisting farmers where natural or man-made disasters have impacted livelihoods. Inevitably, these projects work to provide farmers access to improved varieties and tools, best practices and inputs. These inputs include fertilizers (which are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support) and pesticides (which are regulated by 22CFR 216.3). Pesticides promoted or donated include insecticides, miticides, nematicides, molluscicides, fungicides,

[21] http://www.ars.usda.gov/is/np/btcotton/btcotton.pdf
[22] http://www.nytimes.com/2010/05/04/business/energy-environment/04weed.html; http://www.rodale.com/monsanto
[23] Including indirect procurement, which may be the following: Through sub-grantees, financial instruments, partners or contained as a seed treatment on purchased seed.

herbicides, bactericides, avicides and rodenticides. Insecticides that are gaseous or produce toxic gas are called fumigants. Almost all field fumigants are for soil treatment and are used for high value crops (like strawberries in the USA). They kill almost everything in the soil, and are almost always Class I toxins (the most toxic).

### Advantages of Field Agriculture Pesticide Treatments

Some pests and diseases significantly reduce yield and yield potential of certain crops. Pesticides, if used wisely and safely in an IPM program, can reduce pests and diseases to tolerable levels, leading to lower risk of crop damage and therefore sustained yield.

### Risks from Field Agriculture Pesticide Treatments

Risks from procurement and use of pesticides in the field are numerous, but the highest risk is encountered when the container of pesticide is opened because of the potential for contact with a high concentration of the AI. Once the AI becomes mixed with water and sprayed, risk decreases somewhat, but not completely, due to dilution. Risk goes up with higher concentrations of AI and with higher AI acute toxicity classes.

As noted in the introduction, AID implementing partners are effectively limited to discussing during training, promoting, purchasing or donating only pesticides registered by EPA for same or similar uses.

## Greenhouses and Nurseries Treated with Pesticides

At present USAID funds numerous agriculture projects that focus at least in part on greenhouse production for high-value off-season crops like tomatoes, cucumbers and herbs. Greenhouses are also used as nurseries to produce seedlings for transplanting to fields. Greenhouse environments provide a variety of benefits for plant production; however, many greenhouses favor pest development as well. The warm, humid conditions and abundant food are ideal for pest populations to build up.

Natural enemies that serve to keep some pests under control in the field may be absent in the greenhouse. For these reasons, pest problems often develop more rapidly and are more severe in enclosed systems. Greenhouses generally tend most likely to be infested with very small crop pests like spider mites, aphids, whiteflies, thrips, scales, mealy bugs, leaf miners and fungus gnats. Common greenhouse diseases include powdery and downy mildews.

### Advantages for Greenhouse Production

The primary advantage of using pesticides in a greenhouse is that the pests are trapped and cannot leave, increasing the chance that they will be poisoned. The use of biological controls (predators, parasitoids or diseases that attack pests) can be effective for the same reason. The website[24] maintained by the National Sustainable Agriculture Information Service contains numerous biological control resources for greenhouse production. And, many small pests can be excluded (and biological controls kept in) by using very fine mesh screens on greenhouse ventilation openings.

### Risks from Treating Greenhouses with Pesticides

The risk of phytotoxicity—the injury to plants by pesticides—is greater in greenhouses where plants grow rapidly and are exceptionally succulent. The greenhouse environment is in some ways more challenging than the field in that it is an enclosed space where pesticides can become concentrated in the air, with little room for error for applicator safety.

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[24] http://attra.ncat.org/attra-pub/gh-ipm.html

Concentrated liquid formulations are generally more hazardous to the applicator than dry formulations as they may be easily absorbed through the skin. Aerosols and fogs usually penetrate dense foliage better than conventional sprays, so better pest control is achieved, but they pose greater risk to people of exposure through the eyes or by inhalation. Special metering or application equipment may be needed and some of the chemicals used may be highly toxic.

Many pesticides labeled for field use are prohibited for greenhouse use because of concerns about worker safety, phytotoxicity leading to crop injury, and/or pesticide resistance management. Regulation 216 applies to greenhouse production in the same way that it applies to field uses. In Annex 7, this PERSUAP evaluates AIs contained in the most common greenhouse pesticides.

### Cotton Harvest and De-linting Chemicals

Although USAID rarely supports large-hectarage cash crops like cotton, there are issues associated with chemicals used on cotton for harvest and de-linting. If needed, the issues and best practices for dealing with cotton harvest chemicals can be found at http://www.ipm.ucdavis.edu/PMG/r114800111.html. For de-linting, risky high concentration sulfuric acid or very dangerous anhydrous hydrochloric acid gas are frequently used. Another, costly, technique is the use of fire to burn lint. Finally, a newer, safer technique using dilute sulfuric acid is the current recommended process. Chemical-resistant gloves, plastic face-shields, rubber splash-proof aprons and carbon-filter respirators[25] are required[26] for handling acids[27]. Prior to disposal, acids must be diluted or neutralized[28].

### Stored Grain and Food Warehouse Pesticide Procurement and Use

Several species of insects, mites and rodents may infest grain in storage. The principal pests that cause damage are the adult and larval stages of beetles, and the larval stage of moths. Rodents (rats and mice) or their hair, urine and feces are another possible stored food contaminants. All may be a problem by their presence, either alive or dead, or in grain that is to be processed for food, or already processed. Stored-grain insects are known as "internal feeders" if they feed within the kernels, otherwise they are referred to as "external feeders."

Stored grain and foods can be turned to dust and contaminants very quickly if a pest population is left unchecked. Generally, warehouses are fumigated to kill all pests at once and the fumigant of choice is aluminum phosphide (which produces highly toxic phosphine gas). Some warehouses use highly toxic methyl-bromide, but this chemical is being phased out of use world-wide due to concerns that it interacts with and decreases the ozone layer. Others may use carbon dioxide. These gases are especially effective against internal grain-chewers, as non-gas pesticides may not reach into the grain. But, all of these gasses are highly toxic to humans, so intense caution must be observed, and serious repeated training needs to be done. Several non-fumigants are also used.

#### Advantages of Warehouse Treatment

The warehouse environment is largely a sealed environment where pests—especially well hidden and protected pests inside grain and food—that are being controlled cannot escape, and are controlled with toxic gases. Bait boxes containing rodenticides can be placed near warehouses to control rodents attracted to the warehouse.

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[25] http://www.labsafety.com/refinfo/ezfacts/ezf320.htm
[26] http://www.cdc.gov/niosh/
[27] http://www.utdallas.edu/ehs/manuals/docs/acid_safety.pdf
[28] http://www.osha.gov/SLTC/healthguidelines/index.html

### Risks from Treating Warehouses with Pesticides

The closed environment and use of highly toxic gases pose unique and potentially deadly risks to humans, especially if they are not trained and equipped properly. Fumigation personnel must be trained (and in most countries, certified) and present in a pair, have self-contained oxygen or specialized canister filter masks, a phosphine meter and chemical resistant gloves. Non-gas warehouse treatments also have specific best practices found at http://fcamin.nic.in/admin/an4.pdf. Most stored grain issues are dealt with using good sanitation practices. Regulation 216 applies to warehouse storage in the same way that it applies to other uses. In Annex 7, this PERSUAP evaluates AIs contained in the most common warehouse pesticides.

## Agricultural Produce Treatment and Preservation

Many agricultural products are treated and preserved, from the household level to food assistance and commercial markets, and USAID is assisting with all of these. For instance, apricots shipped from the region to Russia and the USA, are treated with sulfur, and many other products are treated with dilute chlorine solutions. Any fresh fruit and vegetable shipment traded between countries is generally treated with aluminum phosphide, producing phosphine gas, one of the most toxic chemicals known. At times, carbon dioxide, a natural but very toxic chemical is used for fumigation. Food additives and preservatives are the domain of the US Food and Drug Administration (FDA), not the EPA, and as such are not covered specifically under Regulation 216.

### Advantages of Produce Treatment

All agricultural produce declines in quality with time and is attacked by microbes, insects and other pests. Thus, treatment with chemicals and by use of physical means (greatly raising or lowering temperatures, or decreasing moisture or water content) is essential to ensure food lasts until consumption, and that sanitary and phytosanitary needs have been addressed for international trade.

### Risks Associated with Produce Treatment

Some naturally occurring chemicals like salt, sugars, weak acids (citric, acetic) or sulfur compounds are relatively innocuous (sulfur was the first known pesticide used 4000 years ago in the Fertile Crescent). But others, like aluminum phosphide can be very dangerous to people who use it without sufficient training, safety equipment and warnings. Phosphides as well as chlorine, carbon dioxide and sulfur compounds are analyzed for safety in Annex 7. These are also discussed in the PER, and the FDA provides many resources for mitigating risks[29].

## Veterinary Pesticide Procurement and Use

Like field agricultural production, USAID also supports ways to increase production in countries reliant on pastoralism or livestock rearing for meat, milk, hides and other products. The singular important pest problem with livestock production involves the annoyance and transmission of diseases by ectoparasite ticks, mites and biting flies. Along with cultural practices and IVM, acaricides and insecticides are used to control these pests. In Annex 7, this PERSUAP evaluates AIs contained in the most common veterinary pesticides.

The FDA and not the EPA regulate animal or human food additives in the USA[30]. They are referred to nowhere in Regulation 216, and are not considered to be pesticides. Thus, they are not covered in this

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[29] http://www.fda.gov/food/foodingredientspackaging/ucm094211.htm
[30] http://www.fda.gov/AnimalVeterinary/Products/AnimalFoodFeeds/default.htm

PPERSUAP. **Bovine spongiform encephalopathy** (**BSE**), commonly known as **mad cow disease**, is caused by feeding healthy cattle rendered proteinaceous remains of the brain and nervous systems of dead or slaughtered cows[31]. There are no known pesticides or antibiotics to manage or control this disease. The best control is prevention by not feeding herbivorous cows with protein from dead infected cows.

### Advantages of Veterinary Pesticide Use

Cattle diseased from tick or fly bites or bothered by biting flies lose weight and do not produce quantity or quality meat and hides. Acaricides and Insecticides reduce these risks.

### Risks from Treating Livestock with Pesticides

One major risk from livestock treatment is the use of livestock dips whereby a deep pit is dug into the ground, generally next to a water source like a river or stream, and filled with a pesticide solution. Livestock are then run through and submerged in the dip. Disposal of the dip water once dipping is complete poses risks to the environment. Occasional floods overrun the dipping pit and carry the dip water down the stream, contaminating the water resource and killing aquatic organism. USAID generally does not support the use of dips.

Instead of dips, many ranchers now use backpack sprayers to apply acaricides directly to their livestock. More recently, herders and ranchers can apply acaricides using pour-on formulations. And, some without resources to purchase a sprayer apply acaricides by using a rag soaked in pesticides and applied using bare hands. But, in all of these instances, farmers must be encouraged to keep and use chemical-resistant gloves for these purposes.

## Water and Sanitation

Water disinfection/sanitization for household and drinking water use presents challenges. The primary chemicals used in Pakistan for water treatment are based on chlorine. Additional chemicals that can less commonly be used include those based on other halogens like bromine, iodine, as well as ozone and hydrogen peroxide. Wikipedia provides a very nice summary of water treatment and some mitigation measures at http://en.wikipedia.org/wiki/Water_purification. The American Chemistry Council has some mitigation measures: http://www.americanchemistry.com/100years/Practices.html.

## Bird Flu Disinfection and Microbiocide Procurement and Use[32]

HPAI virus can be serially transmitted between and among wild and domestic bird populations and can decimate domestic production and harm trade. Migrating wild birds may transfer HPAI long distances and across international borders, and are one source of the current outbreaks. Another source is the movement of infected birds in the commercial trade, both caged wild birds and poultry. The HPAI virus may also be transmitted to humans by direct contact with infected birds, body parts and waste, leading to sickness and potential death. The worst-case scenario is that the virus may mutate to become able to be transmitted from human to human, leading to an epidemic or pandemic.

USAID recognizes the highly pathogenic H5N1 avian influenza virus as a threat to public health, economic stability, and development in affected and at-risk countries. Pakistan is considered to be HPAI epidemic country[33] and in the mid-2000s USAID and FAO contracted HPAI activities there.

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[31] http://en.wikipedia.org/wiki/Bovine_spongiform_encephalopathy
[32] http://www.usaid.gov/our_work/global_health/home/News/news_items/avian_influenza.html
[33] http://www.usaid.gov/our_work/global_health/home/News/ai_docs/ai_outbreaks.pdf

HPAI activities involve extensive use of microbiocides to kill pathogens. These are the same as disinfectants used for cleaning water of pathogens. EPA's list of 100 disinfectant pesticide products registered for use against AI is at: http://www.epa.gov/pesticides/factsheets/avian_flu_products.htm. Thus, this PERSUAP will refer to and not duplicate this process. However, in Annex 7, this PERSUAP evaluates AIs contained in the most common water disinfectant microbiocides (pesticides).

#### Advantages for HPAI and Water Treatment

The HPAI virus and other microbial contaminants can be transmitted from dead birds, bird waste and bird parts. Disinfection reduces these risks. Water is treated by many of the same microbiocides as HPAI disinfection, as well as by ultraviolet light.

#### Risks from Treating HPAI and Water with Pesticides

Water disinfection with chlorine gas from sodium chlorite and chloramines sometimes react with organic matter to produce side product chemicals, some of which are called trihalomethanes (THM). Mitigation of THMs includes reducing the amount of organic matter in water before treatment. Most disinfectants are Class I toxins and are highly corrosive to skin eyes and mucous membranes. Thus, they require the use of gloves, splash-proof safety glasses and a carbon-filtered facemask or respirator.

### Malaria and Dengue Control Pesticide Procurement and Use

Malaria acutely infects 300 to 500 million people worldwide, and 1 to 2.5 million people die annually due to the disease. Malaria is caused by protozoans of the genus *Plasmodium*, which are transmitted to people living in at-risk areas by mosquitoes of the *Anopheles* genus. Malaria control involves reducing the populations of these mosquitoes and their transmission rates. The use of DDT is permitted for mosquito control under the POPs Treaty (see Annex 19), and is recommended for Indoor Residual Spraying (IRS) mosquito control by both WHO[34] and USAID[35]. Both have produced guidance for DDT use. For instance, in 2007, USAID produce a PEA for IVM for Malaria Vector Control[36]. Later in 2007 and 2008, USAID produced a Supplmental EAs for pilot use of DDT in Uganda[37] and Mozambique[38], respectively.

Malaria is endemic in most areas of Pakistan; however, USAID no longer works on malarial mosquito control there. In the future that could change if malaria once again reaches epidemic proportions. Rational activities might include the use of IRS with an insecticide of mosquito resting sites on internal walls of adobe houses. Other activities could include the provision of insecticide-treated bed nets and area nets.

According to the United Nations (UN), Pakistan's RBM strategy is lagging far behind the international goal of reducing the disease worldwide by 50 percent by 2010, mainly because of a lack of skilled staff and a shortage of funding[39].

The Disease Early Warning System (DEWS) in Pakistan has recently reported high number of dengue fever cases across the provinces of Punjab, Sindh, Balochistan and KPK. A total of 4,388 suspected cases were reported so far from 01 January to 11 September 2013. The province of KPK reported the highest number of cases so far (3,177 cases) followed by the province of Sindh (1098 cases).

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[34] http://whqlibdoc.who.int/hq/2011/WHO_HTM_GMP_2011_eng.pdf?ua=1
[35] http://pdf.usaid.gov/pdf_docs/PDACH948.pdf
[36] http://pdf.usaid.gov/pdf_docs/PNADI081.pdf
[37] http://pdf.usaid.gov/pdf_docs/PNADO019.pdf
[38] http://pdf.usaid.gov/pdf_docs/PNADO016.pdf
[39] http://www.irinnews.org/InDepthMain.aspx?InDepthId=10&ReportId=33684&Country=Yes

Unlike malaria, Dengue Fever and Chikungunya[40] are viruses transmitted by Aedes mosquitoes, particularly *Aedes aegypti*. These mosquitoes usually live between the latitudes of 35° North and 35° South below an elevation of 1,000 meters (3,300 ft.). They typically bite during the day, particularly in the early morning and in the early evening. Other *Aedes* species that transmit the diseases include *A. albopictus*, *A. polynesiensis* and *A. scutellaris*. Humans are the primary host of the virus.

Both Dengue Fever and Chikungunya are fast emerging pandemic-prone diseases in many parts of the world. Dengue flourishes in urban poor areas, suburbs and the countryside but also affects more affluent neighborhoods in tropical and subtropical countries. Dengue fever (DF) is endemic in Pakistan with annual seasonal outbreaks observed every year. The country witnessed a major outbreak of dengue fever in 2011. Punjab was the worst affected province with over 250,000 suspected cases including 203 deaths reported from this outbreak in 2011.

Dengue Fever is increasingly becoming an epidemic in Pakistan. Due to the high cost of treatment, the disease spread more rapidly in 2014 than in previous years. It has attracted the attention of the Government of Pakistan, especially the Punjab Government since it is widespread in that particular province of the country. In 2013, a Dengue outbreak occurred in Swat district of KPK province in Pakistan. As of 25 September 2013, a total of 6376 suspected cases, including 23 deaths (case–fatality rate 0.36%), were reported from this district since 7 August 2013. Laboratory tests performed at the National Institute of Health (NIH) in Islamabad, Pakistan, confirmed the diagnosis and detected three sero types of dengue fever (DEN-1, DEN-2 and DEN-3) as the causative strain of this current outbreak.

### Risks with IRS and ITNs Technologies

Health and environmental risks from the use of IRS include risk to applicators if they do not use PPE properly and risks to inhabitants if they do not follow instructions for leaving the residence and covering belongings during and immediately following spraying. Water resources can be at risk; applicators must properly rinse their sprayers and dispose of leftover pesticide following best practices and away from open water sources. Other risks include the diversion of especially DDT, or other chemicals, from IRS to crop spraying, which is not recommended. USAID has produced a PEA for IRS[41], and this document guides pesticide decision-making with IRS.

Health and environmental risks from the use of ITNs include potential exposure of humans and the environment during distribution, storage, use, and disposal of bed net re-treatment pesticides, mostly synthetic pyrethroids. The use of Long-Lasting Insecticide Treated Nets (LLITNs), such as those used in Pakistan and throughout South Asia, avoids this because they last so long that they are never re-treated with pesticides. WHO-recommended ITN pesticide products are classified by EPA as only “moderately” toxic to humans, and with adequate safety precautions, the risk of adverse effects from their use is slight. However, these products are highly toxic to aquatic organisms, and precautions are necessary to assure that they not contaminate lakes, streams and other bodies of water supporting aquatic life. USAID has produced a PEA for ITNs[42], and this document guides pesticide decision-making with ITNs.

### Mitigating Risks with IRS and ITNs Technologies

Where DDT is used for IRS, the primary risk is that the DDT will move out of the health sector to the agriculture sector and be used on crops. Strong governance in the IRS program and tight control over the DDT reduces the risk. Other application risks are mitigated with frequent training and refresher training

[40] http://www.who.int/denguecontrol/arbo-viral/other_arboviral_chikungunya/en/
[41] http://pdf.usaid.gov/pdf_docs/PNADI081.pdf
[42] http://pdf.usaid.gov/pdf_docs/PNACP696.pdf

on BMPs as well as provision and use of PPE.  Risks to home occupants are mitigated by training and use of BMPs.

ITN risks are reduced by use of LLITNs, which do not need retreatment.  However, where non-long lasting bednets are used and retreated, the retreatment with synthetic pyrethroid pesticides lead to risks to water systems and skin irritation to applicators.  Mitigation includes training and use of PPE, as well as use of only LLITNs.

### Construction Pesticide Procurement and Use

Construction generally involves the use of best practices that avoid permitting standing water on-site and the use of best practices with pesticides to control future termite infestations in the structure(s) being erected.  Malaria and dengue transmission are highest where there is standing water.  Thus, the primary mitigation recommendation for reducing malaria and dengue transmission near construction sites is to avoid the presence of continuous (more than one week) standing water in puddles in borrow pits and open containers where malarial and dengue mosquitoes can breed.  Thus borrow pits and open containers must be avoided and if they become filled with water, they must be emptied or treated with a mosquito larvicide.  Such larvicides are evaluated in the PER and referenced Annex 7.

Termite control on construction sites involves best practices to avoid dumping wood scrap pieces or tree and stump remains as fill around the building foundation (a common practice) after erection.  Most modern buildings in areas commonly infested by termites also apply a persistent termiticide to the soil around the foundation.  IPM practices and permitted termiticides are found at the end of Annex 1.

### Rights of Way Herbicide Procurement and Use (power/cable lines, roads, irrigation canals, runways and so on)

Herbicides are pesticides used to control unwanted vegetation (weeds). Weeds along rights-of-way include those that are a safety hazard, a nuisance, or are unsightly to the traveling public. Right-of-way weeds also include those plants that impede the use and maintenance of rights-of-way, cause injury to workers, interrupt flow of electricity or communications, are declared a noxious weed under state laws, crowd out desired native plants, damage structures and ballast, or reduce crop yield or injure livestock.

Control methods applied to rights-of-way must be part of a sound weed management program that is sensitive to the environment. Herbicide application is one of the methods available to rights-of-way managers.

#### Risks with Right of Way Herbicides

Since relatively large quantities of herbicides may be applied, water pollution is of primary concern. Herbicides must not be applied within 24 hours a rainstorm, in order to manage runoff.

## 2.5 Pakistan Pesticide Sector and Evaluation of Pakistan Pesticide Risks

### Pakistan International Obligations

Pesticides

- Rotterdam Convention on Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides (signatory 1999, ratified 2005) See current list of PIC chemicals in Annex 19.

- Stockholm Convention on Persistent Organic Pollutant (POPs) (signatory since 2001, ratified 2008) See current list of POP chemicals in Annex 19.
- Basel Convention on the Control of Transboundry Movement of Hazardous Wastes and their Disposal (accession 26-07-1994)
- Montreal Protocol[43] on Substances Depleting Ozone Layer (ratified on 18.12.1992) This list includes chlorofluorocarbons, hydrochlorofluorocarbons, and hydrofluorocarbons, one of which is methyl-bromide, commonly used in agriculture for fumigating soil.

### Stockholm

Persistent Organic Pollutants (POPs) are chemicals that are toxic, persistent in the environment, and liable to bioaccumulate. These chemicals are among the most dangerous and highly toxic pollutants released into the environment every year by human activity. Their effects on humans can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system. Some POPs are also considered to be endocrine disrupters, which, by altering the hormonal system, can damage the reproductive and immune systems of exposed individuals as well as their offspring; they can also have developmental and carcinogenic effects.

The Stockholm Convention on Persistent Organic Pollutants was established to eliminate or restrict the production and use of POPs. Through the World Bank's Global Environment Fund (GEF), countries are creating sustainable capacity and ownership so as to meet their obligations under the Stockholm Convention including preparation of POPs National Implementation Plans. A National Implementation Plan describes how each country will meet its obligations under the Convention to phase-out POPs sources and remediate POPs contaminated sites.

### Rotterdam

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, more commonly known simply as the Rotterdam Convention, is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labeling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged make sure that producers within their jurisdiction comply.

### Basel

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries. It does not, however, address the movement of radioactive waste. The Convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate.

### Montreal

The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by

[43] http://en.wikipedia.org/wiki/Montreal_Protocol

phasing out the production of numerous substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989, followed by a first meeting in Helsinki in May 1989. Since then, it has undergone seven revisions. It is believed that if the international agreement is adhered to, the ozone layer is expected to recover by 2050. Methyl bromide used for agricultural fumigation is one of the protocol chemicals being phased out worldwide.

### Labor

#### International Labor Organization (ILO) and Pakistan[44]

Pakistan is an ILO member state. The ILO website for Pakistan references occupational safety and health regulations, including hazards from chemicals and pesticides. Pakistan 2003 hazardous substances rules and safe pesticide handling regulations are found at the following website: http://faolex.fao.org/docs/pdf/pak64438.pdf. The regulations follow very closely those promoted by FAO.

## Pakistan Pesticide Sector Risks

Annex 17 provides an analysis of the organization of the pesticide sector in Pakistan. The following table consolidates and prioritizes pesticide system risks found in Pakistan. This table should be shared with other donors in Pakistan (included as a recommendation in Executive Summary).

**TABLE 9: CONSOLIDATED AND PRIORITIZED PESTICIDE SYSTEM RISKS FOUND IN PAKISTAN**

| Problems, Constraints or Risks in the Pakistan Pesticide Cycle of Use | Recommendations for Donors and USAID Projects | USAID Priority |
|---|---|---|
| Banned POPs and PIC chemicals still enter Pakistan via informal channels | Sensitize GOP officials about the threats to Pakistan's trade potential, and do training | High |
| Large quantities of obsolete pesticides, including POPs and PIC chemicals, remain | Combine resources from several donors to implement disposal programs | Med |
| Lower quality, illegal & pirated Chinese AIs and pesticides present | Do repeated training on pesticide quality choices | Med |
| Funds for analyzing and monitoring pesticides and residues is insufficient | Donors and produce exporters and authorities combine resources | Med |
| Limited resources for pesticide regulations enforcement | Taxes need to be levied from agriculture sector | Low |
| Limited resources for extension | Do demonstration farms and field days | High |
| | | |
| Lack of pesticide toxicity awareness by farmers | Do repeated training on pesticide choice and risks | Med |
| Limited farmer knowledge of pest Identification (ID) & IPM tools | Increase knowledge, do repeated training on IPM | High |
| Over- and under-applications of pesticides | Do repeated training on calibration & application | Med |
| Illiterate farmers cannot read pesticide labels | Do repeated training on pesticide cautions | High |

[44] http://www.ilo.org/dyn/natlex/natlex_browse.country?p_lang=en&p_country=PAK (Pakistan)

| | | |
|---|---|---|
| Wrong pesticide applied for pest | Do repeated training on pesticide choice | High |
| | | |
| Proximity to major cotton, tobacco and rice production & chemicals | Diversify production, knowledge & input demand | High |
| Pesticide shops with limited safety equipment (PPE) on hand | Train shop-keepers and farmers on proper pesticide safety | Med |
| Pesticides subdivided into unlabeled containers, like empty water bottles, and sold | Train shop-keepers and farmers on proper pesticide safety | Med |
| Pesticides stored in the home, often in unlabeled containers | Do repeated training on proper pesticide storage | High |
| | | |
| Pesticide mixing with bare hands and little use of PPE by pesticide appliers | Do training on proper mixing and PPE to use; provide PPE | High |
| Pesticides applied at wrong time of day and with winds too high, and rain | Do repeated training on application times risks | Med |
| Back-pack sprayers leak onto spray personnel | Do repeated training on sprayer maintenance | High |
| | | |
| DDT and endosulfan available in bazaars and stores, and used | Do repeated training on pesticide choice & quality | High |
| Toxic aluminum phosphide present in input stores | Do repeated training on pesticide choice & quality | High |
| Locust outbreak pesticide over-donations are sold to farmers | Pesticide donation programs need better inventory control | Low |
| Proper unused pesticides & empty container disposal lacking | Do repeated training on proper disposal | High |

## Pakistan Pesticide Sector Risk Reduction

Reduced risk inherent in the cropping and input systems in Pakistan

- Many less toxic products are being registered and used by farmers in Pakistan, than compared with just 8 years ago when some highly toxic chemicals were still being registered and promoted.
- Many farm stores in developing countries are beginning to stock ever-increasing quantities of green-label biological pesticides (like neem oil, Bt, oils with copper and sulfur, and extracts of garlic and chili pepper) made in India or Pakistan for both organic and conventional markets.
- Lower costs for biologically derived, highly effective and approved for Organic insecticide products like spinosad, an extract from a soil bacterium are now a reality. Many newer nicotinoid insecticides are also now available.
- The fact that Pakistan will, in many cases, have to follow European standards systems in order to reach European markets. Many farms oriented for export will be ever more organized following S&C systems like GlobalGAP, Organic, Fair Trade and others, which inevitably contain recommended IPM measures that work and reduced-risk pesticide products.
- The increasing world-wide availability and use of small, single-use sachets and smaller bottles of pesticides (as opposed to one and five liter bottles) with labels containing important and potentially life-saving information (in local languages) that are marketed by the formal pesticide

importer/distributor sector. These small quantities and labels help resolve on-farm pesticide quantity storage, illegal subdividing and use issues.

- The likely small scale of most USAID-supported beneficiary farms, combined with lack of financial resources, will limit the quantities of synthetic pesticides used, and will promote the use of other cultural techniques to solve pest issues.

### Conclusion

There still remain some issues with pesticides that can increase the risk for errors to occur, and thus the risks that farmers, laborers, farm family members, and even international consumers may be acutely or slowly poisoned and/or their environment may become polluted and damaged. Thus the pesticide risk profile for Pakistan is higher than might be encountered in some more developed as well as other developing countries, though it is rapidly changing for the better as S&C-GAP systems are being implemented and EU rules for import tolerances are adopted. Extra care will be needed with emphasizing and implementing mitigation measures that work.

## 2.6 Climate Change and Pakistan Agriculture

Many man-made factors, including consequences of increased agricultural production, likely exacerbate global climate changes. Waterlogging and indiscriminate use of nitrogen-containing fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that AN and CAN are prohibited from USAID support) increases nitrous oxide emissions from croplands. These may increase the rate of organic matter decomposition, the release of gasses that exacerbate global warming, and soil degradation.

According to several sources, livestock and livestock-related activities[45] such as deforestation, as well as increasingly fuel-intensive farming practices, are responsible for over 18% of human-made greenhouse gas emissions, including:

- 9% of global carbon dioxide emissions
- 35-40% of global methane emissions (chiefly due to enteric livestock fermentation and manure decomposition)
- 64% of global nitrous oxide emissions (chiefly due to fertilizer use)

Enteric fermentation leads to the production of methane. Methane is a greenhouse gas that has 56 times more global warming potential than carbon dioxide over a 20-year time horizon. Furthermore, clearing wild or forestland for new grazing areas or crop fields reduces the land's ability to act as a carbon sink.

Setting fire to vegetation to clear land or promote new growth for livestock to graze on may also contribute some to global warming. Destruction of forage areas can increase the rate of desertification, impacting climate change. It can also alter the earth's land cover, which can change its ability to absorb or reflect heat and light. Carbon dioxide can be produced, and electricity used, during production of synthetic pesticides, mineral fertilizers and animal feeds. Some nitrous oxide is produced by livestock manure, but composting reduces this.

Decreased water availability during dry seasons, as well as new or increased insect pest and disease incidence, will likely decrease crop yields in most tropical and sub- tropical regions. In Africa and Latin America many rain-fed crops are near their maximum temperature tolerance. Small climate changes that increase temperatures—even incrementally—can cause yields to fall precipitously. Various studies in

[45] http://www.worldwatch.org/files/pdf/Livestock%20and%20Climate%20Change.pdf

South Asia and China have established that just a 1 degree Celsius increase in temperature during the wheat-growing season may cause a decline in yield of 3 percent. In fact, decreases in agricultural productivity of up to 30% over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places as water temperature and acidity increase, leading to coral bleaching, reduced food chain plankton production and the resultant reductions in fisheries used for human food.

Increases in temperatures will favor the spread of insect and disease pests further toward more northerly and southerly extremes. Many pests that would die while overwintering will now survive. The increase in crop pests will lead to the use of more pesticides, which will increase the resistance of pests to these pesticides. And, human diseases such as malaria and dengue have increased in recent years and are moving steadily northward in their range.

Because of illegal tree cuttings, both for wood sale and clearing farmland, the $CO_2$ sequestration by forests and other forest biomass has decreased. As a result of changes in land use and reclamation of new lands, $CO_2$ absorption by soils has increased. Then, $CO_2$ emissions released have increased, due to the intensive use of soils.

The safety of agricultural crops and fisheries also may be threatened through contamination with metals, chemicals, and other toxicants that may be released into the environment as a result of extreme weather events, particularly flooding, drought, and wildfires, due to climate change[46]. All of these factors combined will challenge food quality and security.

In the summer of 2010, unusually heavy monsoon rains in Pakistan, likely due to global climate changes, displaced some 14 million people, and killed over 1,000. Floods and soil water-logging hamper planting. The current rapid retreat of mountain snow cover and glaciers is also attributed to increased temperatures due to global warming. Since about 70 % of Pakistan is considered arid or semi-arid, reliance on dependable but not overabundant rains is critical. Any deviations—from drought to flooding—will upset the balance required for basic agricultural production.

Challenges in reducing or reversing global warming include finding land-use strategies and crops that restore degraded ecosystems and soils by improving water use efficiency, enhancing soil quality and sequestering carbon in soil biomass. The use of irrigation—especially irrigation such as drip that conserves water—can reduce reliance on erratic and often unreliable rains. By using forage and fodder instead of manufactured livestock feed, livestock gut digestion is improved, reducing methane production. Composting manure can reduce the amounts of nitrous oxide produced by livestock manure.

The use of manure instead of chemical fertilizers reduces the burning of fossil fuels for the production of mineral fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support). By using forage and fodder instead of manufactured livestock feed, livestock gut digestion is improved, reducing methane production. Proper pasture use and stocking can decrease overall numbers of livestock required at the beginning of a season, thus decreasing methane production.

The ever-lengthening Pakistani summer season no longer has a sufficient early-season cool component needed for wheat germination. Environmentalists and scientists say that Pakistan should urgently promote alternative crops to wheat because, as temperatures rise due to global warming, yields of the

[46] http://www.cdc.gov/climatechange/effects/foodborne.htm

grain that is a staple food for most Pakistanis are predicted to fall[47]. Pakistan's efforts in these areas are still at an early stage.

Before the Global Change Impact Studies Centre was set up in 2001, there was almost no climate change research in the country. The center established a task force on climate change in October 2008, and submitted a comprehensive report in February of 2010 which outlines ways to respond to the challenges of global warming in Pakistan's water, agriculture and forest sectors. One agriculture university has developed drought- and flood-resistant crop varieties, including a "Maxipak" wheat strain that is only one foot tall and can withstand heavy rains.

[47] http://reliefweb.int/node/371883

# SECTION 3: PESTICIDE EVALUATION REPORT

This part of the PERSUAP, the PER (Pesticide Evaluation Report), addresses pesticide choices based upon environmental and human health issues, uses, alternate options, IPM, biodiversity, conservation, training, PPE options, monitoring and mitigation recommendations according to the twelve Regulation 216.3(b)(1) Pesticide Procedures Factors, outlined and analyzed below.

Reg. 216.3(b) (1) (i) stipulates: "When a project includes assistance for procurement or use, or both, of pesticides registered for the same or similar uses by USEPA without restriction, the Initial Environmental Examination for the project shall include a separate section evaluating the economic, social and environmental risks and benefits of the planned pesticide use to determine whether the use may result in significant environmental impact. Factors to be considered in such an evaluation shall include, but not be limited to the following:" (see box, right)

**THE 12 PESTICIDE FACTORS**

***Factor A**. USEPA Registration Status of the Proposed Pesticides*

***Factor B**. Basis for Selection of Pesticides*

***Factor C.** Extent to which the proposed pesticide use is, or could be, part of an IPM program*

***Factor D**. Proposed method or methods of application, including the availability of application and safety equipment*

***Factor E.** Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards*

***Factor F.** Effectiveness of the requested pesticide for the proposed use*

***Factor G**. Compatibility of the proposed pesticide use with target and non-target ecosystems*

***Factor H.** Conditions under which the pesticide is to be used, including climate, geography, hydrology, and soils*

***Factor I**. Availability of other pesticides or non-chemical control methods*

***Factor J**. Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide*

***Factor K**. Provision for training of users and applicators.*

***Factor L**. Provision made for monitoring the use and effectiveness of each pesticide*

Pesticides can be home-made (artisanal) or synthesized in a factory, and may contain either natural extracts from plants, microbes, spices, oils, minerals, or synthesized chemicals, or occasionally both. Pesticides generally contain more than just the AI; they also contain a carrier (water, oil, or emulsion), emulsifiers, synergists, safeners, adhesives and other components.

Pesticides generally contain just one AI, but can contain more than one AI, in a mixture. When produced commercially, each pesticide is made, marketed and sold with a product commercial name. This name, in addition to artisanal[48] products, is the "pesticide" that Regulation 216 refers to. These pesticide names can be ubiquitous (like Roundup for products containing the AI glyphosate) or can be given different names in different countries or regions depending upon cultural and linguistic differences and clever marketing.

It would be ideal to find pesticides for every need that are Class IV acute toxicity, have no chronic human health issues, no water pollution issues and no aquatic ecotoxicity issues. Such pesticides do not exist. Almost every pesticide known, including so-called natural pesticides has toxicity to at least one aquatic organism, or bees, or birds.

[48] Little information exists on use of artisanal pesticides in Pakistan, however those used in India are likely to also be used in Pakistan, see: http://www.indiaenvironmentportal.org.in/content/7373/homemade-pesticides/

Pesticide AIs used for general and field use spraying—as well as each of the other special use sectors—are analyzed in Annex 7 of this PERSUAP, with the codes for special sector uses in column 3, as follows:

Seed = S

Greenhouse Crops = G

Food Security/Warehouses = W

Veterinary = V

Health/Malaria/Dengue = M

Construction/Termites = T

Microbial Disinfectants (Water, Sanitation and Avian Influenza) = D

## 3.1 Factor A: USEPA Registration Status of the Proposed Pesticides

Pakistan assistance projects activities are effectively limited to promoting during training, promoting, recommending, subsidizing or purchasing pesticides containing active ingredients (AIs) in products registered in the host country and in the US by the EPA for the same or *similar* uses. Emphasis is placed on "similar use" because a few of the crops and their pest species found overseas are not present in the US, and therefore pesticides may not be registered for the exact same use, but often are registered for similar pests and pest situations. Annex 7 provides EPA registration status for each AI found in each pesticide registered as same or similar use for procurement and use in Pakistan. The only way that a project can use pesticides rejected by this PERSUAP analysis is to write an EA specifically for the desired rejected pesticides. An EA will go into much more depth on such chemicals, and will make and ensure specific mitigation measures to be taken to reduce risks.

### Issue: Products containing active ingredients not EPA-registered

Annex 7 shows in column 4 pesticide AIs in no EPA-registered pesticides and colors each one with red shading, meaning "Do Not Use on USAID Projects". Annex 7 colors with green pesticide AIs that pass all of the 12 factor safety analyses found in this PER, and possess "acceptable risks". This means that the AIs are in products registered as same or similar use for procurement and use in Pakistan that are also registered by EPA for same or similar use, not RUP pesticides, generally not Class I pesticides, not known carcinogens, and not known water pollutants. The fourth column of the table in Annex 7 shows EPA registration status of each pesticide AI. The fifth column shows whether or not there are RUP products containing that particular AI, with an indication of the relative amount that are RUP (few, some, most, all).

Pesticide AIs colored in yellow are EPA registered and can be used—with caution. They generally require additional measures to ensure acceptable safety. In cases where there are few, some or most RUP products, PERSUAP users can do simple web searches that show which products are RUP and which are not RUP. Furthermore, at the end or bottom of Annex 7, there are websites to which readers/users can directly link to get the most up-to-date RUP analyses. In cases where there are choices among Classes I, II or III pesticide products, users should always (with few exceptions where there are no choices and there are guaranteed options for safety) choose the least toxic product that will accomplish the task, and not procurement and use Class I chemicals because they are too toxic for the untrained and unprotected to use.

Pesticide AIs colored in red are either not EPA registered, banned or being phased out internationally, mostly Class I, Ia or Ib, are known carcinogens or known water pollutants. These are prohibited for use on USAID-funded projects due to lack of compliance with Regulation 216 and presence of unacceptable risks given the current knowledge of the Pakistan pesticide system risk profile as compiled above in Section 2.5.

Pesticide AIs that are not registered by EPA are either cancelled for use in the USA due to unacceptable risks, or have insufficient market demand and have thus not been through EPA's battery of environmental and human health tests.

The 2014 USAID Pakistan projects that were sent questionnaires all note that no PERSUAP-rejected pesticides were used on their projects. None of them supported pesticides rejected by the 2013 U-PERSUAP Update.

#### Recommendations for Mitigation

- Pakistan projects' beneficiaries not use with USAID resources products containing these active ingredients, below, that are not EPA registered for same or similar use (shaded in red in Annex 7).

### Issue: Restricted Use Pesticides (RUPs)

The EPA has developed a system for dealing with pesticides with inordinate risks to human health and/or environment for various uses. In the USA, farmers who wish to purchase and use RUPs must receive (and pay for) specialized training and certification to increase awareness of the risks and ways that can be used to mitigate these risks. These *Certified Applicators*, or those under their direct supervision, must follow the pesticide label instructions and only use the product for purposes covered under their certification. Further, in the USA, some states may require that certain active ingredients not listed on the Federal list be classified as "restricted" in their states due to local conditions, generally related to environmental concerns.

The EPA classifies a particular pesticide as restricted if it determines that the pesticide may be hazardous to human health or to the environment *even when used according to the label*.

As noted above, in quotes under 3.0, Regulation 216.3 (b) (1) (i), "pesticides registered for the same or similar uses by USEPA *without restriction…*". The interpretation of "without restriction" is that approved pesticide products will not be RUPs, regardless of RUP criteria or basis (the reason they are designated as RUPs). It is important to note that RUP products may be designated as such, by EPA, due to either: 1. Inordinate risk (hazard) to users; or 2. Inordinate risk to the environment; or 3. Sometimes both. Regulation 216 considers this distinction and deals with it in subparts (ii) and (iii). The 1990 US Farm Bill requires that all RUP applicators keep accurate records of RUP use[49].

Annex 7 shows in column 5 whether or not each AI is present in RUP products, with relative quantities of RUP products containing each AI. Some of these are shaded red, meaning "Do Not Procure, Support or Use on USAID Projects, while some are shaded yellow, meaning "Caution, Investigate Further or Use with Conditions on USAID Projects". Some products containing these AIs have issues and some are designated as RUPs (but others are not, so extra investigation is required). Therefore, several of the

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49

http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateQ&navID=PesticideRecordkeepingProgram&rightNav1=PesticideRecordkeepingProgram&topNav=&leftNav=ScienceandLaboratories&page=PesticideRecordkeepingProgram&resultType=

pesticide products being made in or imported to Pakistan are designated as RUPs by the USEPA (compiled in Annex 7, column 5) and these specific RUP products are not to be promoted or used on Pakistan assistance projects. However, distinctions and references are provided to EPA-designated non-RUP products containing the same AI as other products, which are RUP.

The tables below show pesticide Active Ingredients (AIs) rejected for procurement, support or use on USAID Pakistan projects, arranged by type of pesticide (red headers indicate "stop –do not use").

### TABLE 10: COMPILATION OF PESTICIDE AIS REJECTED FOR SUPPORT OR USE ON USAID PAKISTAN PROJECTS

| **Insecticide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)** |
|---|
| • acrinathrin (not EPA registered)<br>• alpha-cypermethrin / alphamethrin (RUP)<br>• azinphos methyl (RUP, Class I, too toxic)<br>• carbofuran (RUP, Class I, too toxic)<br>• cadusafos (not EPA registered)<br>• carbosulfan (not EPA registered)<br>• cartap hydrochloride (not EPA registered)<br>• chlorfenvinphos (not EPA registered)<br>• chlorfluazuron (not EPA registered)<br>• chlorpyrifos-ethyl/chlorpyrifos (no registration for agriculture or construction)<br>• clothianidin (high risk for honeybee colony collapse disorder)<br>• cypermethrin (registered for household use only, not agriculture)<br>• cyromazine (known water pollutant)<br>• diafenthiuron (not EPA registered)<br>• dichlorvos/DDVP (RUP, Class I)<br>• emamectin benzoate (agriculture and tree injection uses RUP)<br>• dimehypo/thiosultap (not EPA registered)<br>• fenoxycarb (known carcinogen)<br>• fenpropathrin (RUP)<br>• fenthion (not EPA registered)<br>• fenvalerate (not EPA registered)<br>• flufenoxuron (not EPA registered)<br>• methidathion (RUP, Class I)<br>• methomyl (RUP, Class I)<br>• metolcarb (not EPA registered)<br>• monomehypo (not EPA registered)<br>• nitenpyram (not EPA registered)<br>• nuclear polyhedrosis virus (NPV) (not EPA registered)<br>• oxydemeton methyl (RUP, Class I, too toxic)<br>• oxymatrine (not EPA registered)<br>• phenthoate (not EPA registered)<br>• phorate (RUP, Class I, too toxic)<br>• profenofos (RUP)<br>• profurite aminium (not EPA registered)<br>• pyridiphenthion (not EPA registered)<br>• quinalphos (not EPA registered)<br>• thiocyclam hydrogen oxalate (not EPA registered)<br>• thiodicarb (RUP)<br>• triazophos (not EPA registered) |

- triflumuron (not EPA registered)
- zeta cypermethrin (18.1% EC product is RUP in USA)

**Acaricide/Miticide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)**

- azocyclotin (not EPA registered)
- fenbutatin oxide (RUP)
- propargite (RUP)

**Nematocide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)**

- fenamiphos (not EPA registered)
- oxamyl (RUP)

**Fungicide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)**

- benomyl (benlate) (not EPA registered)
- bromothalonil/1,2-dibromo-2,4-dicyanobutane (Class I, too toxic)
- diniconazole (not EPA registered)
- enestroburin (not EPA registered)
- epoxiconazole (not EPA registered)
- fenoxanil (not EPA registered)
- fentin hydroxide (RUP)
- fluquinconazole (not EPA registered)
- flusilazole (not EPA registered)
- fthalide/phthalide (not EPA registered)
- fungal proteoglycan (not EPA registered)
- hexaconazole (not EPA registered)
- iprobenfos (not EPA registered)
- iprovalicarb (not EPA registered)
- kasugamycin (not EPA registered)
- maneb (EPA registration canceled)
- penconazole (not EPA registered)
- pencycuron (not EPA registered)
- prochloraz (not EPA registered)
- procymidone/sumisclex (not EPA registered)
- propineb (not EPA registered)
- tolclofos-methyl (not EPA registered)
- tricyclazole (not EPA registered)
- tridemorph (not EPA registered)
- validamycin (not EPA registered)

**Herbicide AIs in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)**

- acetochlor (RUP)
- alachlor (RUP)
- amidosulfuron (not EPA registered)
- atrazine (RUP, known ground water pollutant)
- bentazon, sodium salt (not EPA registered)
- bromacil (known ground water pollutant)
- butachlor (not EPA registered)

| |
|---|
| • cinosulfuron (not EPA registered)<br>• difenzoquat (not EPA registered)<br>• diflufenican (not EPA registered)<br>• diuron (known carcinogen, known water pollutant)<br>• ethoxysulfuron (not EPA registered)<br>• flumorph (not EPA registered)<br>• fluorglycofen-ethyl (not EPA registered)<br>• haloxyfop-R-methyl (not EPA registered, known carcinogen)<br>• haloxyfop-P-methyl (not EPA registered, known carcinogen)<br>• hexazinone (known ground water pollutant)<br>• isoproturon (not EPA registered)<br>• isoxaflutole (RUP, known carcinogen)<br>• MCPA-Na (Class I, too toxic)<br>• metazachlor (not EPA registered)<br>• metolachlor (known ground water pollutant)<br>• metsulfuron (not EPA registered)<br>• oxadiargyl (not EPA registered)<br>• paraquat (dichloride) (RUP, Class I)<br>• picloram (known ground water pollutant)<br>• pretilachlor (not EPA registered)<br>• propisochlor (not EPA registered)<br>• prosuler (psoralen) PGR (not EPA registered)<br>• prosulfocarb (not EPA registered)<br>• pyrazosulfuron-ethyl (not EPA registered)<br>• s-metolachlor (known ground water pollutant)<br>• sulcotrione (not EPA registered)<br>• terbutryn (not EPA registered) |
| **Microbicide AI in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)** |
| • bromine chloride (Class I, too toxic)<br>• formaldehyde (Class I, too toxic, known carcinogen)<br>• quaternary ammonium (not EPA registered)<br>• sulfuric acid (RUP, Class I, too toxic) |
| **Fumigant AI in products registered by Pakistan, and Recommended by this PERSUAP for BEO rejection for use on USAID projects (*with reason for rejection*)** |
| • methyl bromide (Montreal Protocol Ban/Phase-Out, RUP, Class I, too toxic) |

### Recommendations for Mitigation

- Pakistan assistance projects and beneficiaries do not procure and use *pesticide products* containing any of the above AIs, that are either not in EPA registered products or are designated by EPA to be RUP (see Annex 7 with references to similar products containing the same AIs, but that are not designated as RUPs) or Class I acute human toxicity.
- Using information in Annex 1, do training on GAPs/IPM, the production and use of pest management plans and safe pesticide use and management. Training will introduce beneficiary farmers to: Pesticides not permitted for procurement and use, those the project recommends, and

those that might be used with significant training and certification; IPM philosophy, tools and tactics; and Safe Pesticide Use practices including use of basic PPE.
- All USAID project offices must have and keep on hand copies of MSDSs for commonly used pesticides. Such MSDSs contain precise information on risks and risk mitigations for each pesticide product, and include measures to take in case of an accidental spill, fire or poisoning. MSDS information can also be used during training.
- As this PERSUAP is amended, Pakistan assistance projects managers must report to USAID changes to less toxic products on the list of pesticides recommended to USAID.

In addition to all of the issues and cautions already listed, another deserves attention: honeybee colony collapse disorder (CCD). Insecticides in the neonicotinoid class have been identified as likely causal factors, among others, linked to CCD. Neonicotinoids are taken up by crop plants and translocated throughout their tissues. They end up in pollen, gutation water and secretions from female reproductive plant parts.

Honeybees can be exposed during spraying, and when they visit flowers to drink liquids and load up on pollen. Thus, neonicotinoid pesticides must not be used when crops are in the flowering phase, or just prior to flowering.

**Recommendations for Mitigation:**

- Exercise caution when using pesticides in the areas of honey production to ensure that honey bees are not effected and damaged. Do not apply neonicotinoid pesticides (acetamiprid, imidacloprid, thiacloprid, and thiamethoxam) near places with honeybee supras and colonies are located. Use Annex 7 to choose pesticides of lower toxicity to honeybees. Where honey production is underway, spray only in the late afternoon, after honeybees are done foraging for the day.

## 3.2 Factor B: Basis for Selection of Pesticides

This procedure generally refers to the practical, economic and/or environmental rationales for choosing a particular pesticide. In general, best practices and USAID – which promote IPM as policy – dictate that the *least toxic* pesticide that is effective is selected. Many farmers choose pesticides based on what choices are available, how much they cost, if they work well and if they are recommended by a neighbor or farm input store employee. So, this PERSUAP recommends that the bases for selection include human safety, environmental and GAP concerns.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that most project beneficiaries choose pesticides based on price, efficacy, availability, safety, environmental protection and extension service advice. One health project, the Women's Hostel Project, FCC Lahore, that promotes mosquito and termite control, followed selection advice in the 2013 PERSUAP, Annex 1.*

### Agriculture (Crop Seeds, Field Crops and Greenhouse/Nursery Crops)

Up until recently, the bases for selection of pesticides have most often been availability, efficacy, and price—not environmental or human safety. Farmers have wanted a pesticide that has rapid knockdown action to satisfy the need to defeat the pest quickly and visibly. They want to see the pest immediately drop on its back with legs twitching and flailing in the air as it dies.

Farmers who will use GAP and processors who will use HACCP systems for export crops or high-value local markets will focus more on factors such as human safety and low environmental impact, by necessity as much as by choice. Such lower toxicity pesticides may take longer to kill the pest – usually after the farmer has left the field – but they are effective, nevertheless.

Another factor of importance is the abeyance of pesticide-specific PHIs (pre-harvest intervals) and MRLs (maximum residue levels), which can be influenced by choosing products with rapid post-application degradation. The most common bases for traditional farmer and other pesticide selection for crops in Pakistan are past experience, neighborhood farmers, pesticide company extension agents and pesticide dealers. Other factors include price, availability and efficacy.

Individual pesticides are generally formulated specifically for each of the above uses, and will be labeled for use on seed or for use in greenhouses. Some pesticides found in Pakistan are formulated and labeled specifically for seed treatment; however the demand and market for specifically labeled greenhouse pesticides is too small, so no specially formulated greenhouse pesticides are available. In any case, this PERSUAP reviews the most common greenhouse pesticides used worldwide in proactive anticipation of markets expanding sufficiently that greenhouse production increases in Pakistan.

### Food Security Treatments and Fumigation of Warehouses

Pesticides and fumigants used for treating stored grains and foods are generally well known in the sector, and are relatively few. Selection is based on what is available, recommended, affordable and efficacious against the pests at hand. Further, the WFP has specifications and guidelines (Standard Operating Procedures) on which pesticides/fumigants to use and how to use them safely[50]. Non-gas warehouse treatments also have specific best practices found at http://fcamin.nic.in/admin/an4.pdf.

### UN's Codex Alimentarius Commission

The Codex Alimentarius Commission was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Program. The main purposes of this Program are protecting health of the consumers and ensuring fair trade practices in the food trade, and promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations, and its website is www.codexalimentarius.net.

### Veterinary for Livestock

Very few pests like disease-transmitting ticks and some biting flies affect livestock and likewise there are few specific insecticides and miticides available for treatment. Most are synthetic pyrethroids due to relative safety of these products over other classes of pesticides. Animal treatment antibiotics, microbials and chemicals are listed and analyzed in Annex 8. Efficacy and cost are the major factors in pesticide selection.

### Water and Sanitation

The primary chemicals used in Pakistan for water treatment are based on chlorine. Additional chemicals that can less commonly be used include those based on other halogens like bromine, iodine, as well as ozone and hydrogen peroxide. Wikipedia provides a very nice summary of water treatment and some mitigation measures at http://en.wikipedia.org/wiki/Water_purification. Mitigation

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50 http://foodquality.wfp.org/FoodSafetyandHygiene/PestManagement/Fumigation/tabid/322/Default.aspx?PageContentID=531

measures are found at: http://www.americanchemistry.com/100years/Practices.html. Water and sanitation chemicals are chosen based upon past experience and cost.

### Avian Influenza Disinfectants and Sanitizers

Because Avian Influenza and water disinfection are controlled by governments and donors, selection is made by them, generally not by beneficiaries. EPA's list of 100 disinfectant pesticide products registered for procurement and use against HPAI in the USA is at: http://www.epa.gov/pesticides/factsheets/avian_flu_products.htm.

Disinfectants are chosen depending upon cost and availability.

### Health/Malaria/Dengue

Governments and donors run control malaria and dengue programs, so they make pesticide selection; generally beneficiaries do not. Each donor, according to their environmental policies, sets pesticide selection precedents. USAID has produced Programmatic Environmental Assessments for malaria control[51] and ITNs[52]. Pesticides are often chosen based on their persistence as well as low resistance by malarial mosquitoes.

### Construction

Termiticides are chosen based on what is available and safest. Permitted termiticides are included in Annex 7 along with field insecticides and are also listed at the end of Annex 1, under Construction Site Termite Control.

### Right of Way Herbicide Use

Herbicides for right of way uses must have low water pollution potential, and must not be applied within 24 hours of a rainstorm. According to Purdue University extension materials found at http://www.agriculture.purdue.edu/fnr/html/faculty/holt/nrca/chapter04.pdf, the following are environmental concerns.

### Precipitation

"Soil moisture and rainfall affect herbicide efficacy. They also influence how long herbicides stay on soil and plant surfaces. Herbicides work best with moderate soil moisture. Excessive soil moisture may keep the herbicide in solution and increase leaching through the soil. Some rain is beneficial after application of root-absorbed herbicides because it moves the herbicide into the soil and in the root zone. Rain during or soon after foliar applications may wash herbicides off the leaves and reduce uptake and effectiveness.

During drought periods plants are stressed and growth is slowed. This causes most translocated herbicides to perform poorly. Even contact herbicides do not perform well under drought conditions as plants produce heavy wax or corky layers of tissue on leaves or stems that protects against excessive transpiration losses. During dry periods herbicides remain on the soil surface until moisture is received to carry them to the root zone. Effectiveness may be reduced if herbicides remain on the soil surface for a long period of time (several days) before rainfall."

[51] http://pdf.usaid.gov/pdf_docs/PNADI081.pdf
[52] http://pdf.usaid.gov/pdf_docs/PNACP696.pdf

### Temperature

"Temperature generally does not affect final weed control. It may, however, affect the amount of time required for the herbicide to kill the weed. As temperature increases, the herbicide effects occur more quickly. In cold weather, the action of herbicides may be slowed. High temperatures can enhance herbicide volatility (change from a liquid to a gas or vapor). Warm temperatures Herbicides increase soil temperature, which increases microbial activity. This can reduce the persistence, hence effectiveness, of residual, soil-active herbicides."

### Light

"Sunlight is essential for photosynthesis and growth. Light may break down some herbicides if they remain on the soil or plant surface for a long time. This process is called photo degradation. Soil incorporation is an effective way of eliminating photo degradation. Since soil incorporation is not possible for rights-of-way, herbicides used on rights-of-way are not light sensitive."

### Issue: Most beneficiaries do not consider factors such as:

- Reducing risks to human health by using products that contain active ingredients with low acute human toxicity and few to no chronic health risks;
- Reducing risks to scarce and valuable water resources on the surface and underground;
- Reducing risks to biodiversity and environmental resources, and the services they provide;
- Risks of resistance development by using the same pesticide over and over.

**Recommendations for Mitigation**

- Where there is a choice of tow or more permitted (by this PERSUAP) pesticides, choose and use those with low human and environmental risk profiles (see decision matrix in Annex 7, MSDSs, and pesticide labels), as practical.
- Pakistan assistance projects staff be aware of biological and naturally derived pesticides, as practical, such as those listed in Annexes 4 and 5, and that are available.
- During training courses, include training on pesticide selection factors based on findings and recommendations of this report, material found in MSDSs and pesticide labels, and material found on pest management websites (like UC Davis IPM site found at: http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html) which can emphasize the importance of pesticide selection factors safety and environment.

## 3.3 Factor C: Extent to which the Proposed Pesticides Use are, or could be, Part of an IPM Program

USAID promotes training in, and development and use of, integrated approaches to pest management tools and tactics whenever possible. This section emphasizes how the proposed pesticides used can be incorporated into an overall IPM strategy. All sectors examined have IPM tactics, including numerous non-synthetic pesticide tactics and tools available.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that most project beneficiaries on agriculture and health projects are trained in and use IPM or Integrated Vector Management for human or livestock pests. Construction and water/sanitation project implementers and beneficiaries do not use IPM.*

The susceptibility of crop plants to pests and diseases is greatly influenced by the general health of the plant (or livestock), as discussed above in Section 1.5. Therefore, good crop management practices can strongly affect IPM, and good agronomic or cultural practices are the most basic and often the most important prerequisites for an effective IPM program. A healthy crop optimizes both capacity to prevent or tolerate pest damage while maintaining or increasing yield potential.

The USDA supports several programs aimed at investigating and developing IPM tools and tactics, including the National Institute of Food and Agriculture (NIFA)[53] and the National Sustainable Agriculture Information Service of the National Center for Appropriate Technology (NCAT)[54]. This PPERSUAP highlights preventive as well as curative IPM practices in Annex 1. USAID projects in agriculture can use this information to make seasonal crop production and protection plans to predict, prevent and control production constraints (pests/diseases).

### Issue: Most Pakistan beneficiaries are not aware of all of the IPM tactics available

**Agriculture (Seed, Field and Greenhouse/Nursery)**

## TABLE 11: STATUS OF USE OF GAP AND IPM TOOLS AND TECHNIQUES IN PAKISTAN

| GAPs/IPM/Tools | Pakistan level | | | FATA-Program Area | | | |
|---|---|---|---|---|---|---|---|
| | Use in Pakistan | Practiced at Farmer Level | Practiced at Institutional Level | Use in Program Area | Practiced at Farmer Level | Practiced at Institutional Level | Remarks |
| Soil nutrient, texture and pH testing | Slightly | Nil | Yes | No | Nil | Yes | |
| Plant resistant/tolerant seed | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |
| Seed treatment with pesticide | Medium level | Nil | Yes | Negligible | Nil | Yes | |
| Solar soil sterilization | Slightly | No | Yes | No | No | No | |
| Raised-bed planting technique | Greater Extent | Yes | Yes | Greater extent | Yes | Yes | |
| Plastic or organic mulches | Slightly | No | Yes | No | No | No | |
| Follow seeding rate & thinning recommendations | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |
| Soil moisture measurements | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |

53 http://www.csrees.usda.gov/pesticides.cfm
54 http://www.attra.ncat.org/

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Use of organic fertilizers (manure, compost) | Greater level | Yes | Yes | Greater extent | Yes | Yes | Farm yard manure is used mostly |
| Use of purchased mineral fertilizers | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |
| Combinations of organic and mineral fertilizers | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |
| Crop rotation | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |
| Pest monitoring with yellow sticky traps | Slightly | No | Yes | No | No | No | |
| Use of green manure crops | Medium extent | Yes | Yes | No | No | No | |
| Early/late plantings/harvestings to avoid pests | Slightly | Yes | Yes | Slightly | No | Yes | |
| Use of trap crops to trap and destroy pests | Slightly | Yes | Yes | No | No | No | |
| Pruning and sanitation of diseased plants/trees | Greater extent | Yes | Yes | Greater extent | Yes | Yes | |
| Planting parasite-attracting plants on field margins | Slightly | Yes | Yes | No | No | No | |
| Inter-planting crops with aromatic herbs (celery, cilantro, parsley) that repel pests | Slightly | No | Yes | No | No | No | |
| Farmer ability to correctly identify pests | Medium | Yes | Yes up to greater extent | Slightly | Yes | Up to medium extent | |
| Farmer ability to correctly identify | Medium | Yes at low level | Yes at high level | Slightly | No | Yes at medium level | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| predators, parasites and diseases of pests | | | | | | | |
| Weekly field scouting to assess pest levels/damage | Slightly | Yes | Yes | No | No | No | |
| Mechanical weed control by hoe or tiller | Greater extent | Yes | Yes | Greater Extent | Yes | Yes | |
| Use of herbicides for weed control | Medium extent | Yes | Yes | Slightly | Yes | Yes | |
| Mechanical pest control by hand picking | No | No | No | No | No | No | Very rarely by some farmers and research institution for research purpose |
| Spot treatment of pest hotspots with pesticides (instead of area or entire field spraying) | No | No | No | No | No | No | Slightly used by institution for research purpose |
| Use of pheromone traps to monitor moth pest levels | Slightly | No | Yes | No | No | No | |
| Use of pheromone inundation to confuse moth mating | No | No | No | No | No | No | |
| Sanitation, pruning and crop residue destruction at end of season | Medium level | Yes | Yes | Slightly | Yes | Yes | |
| Apply local artisanal plant extracts to kill pests | Slightly | No | Yes | No | No | No | |
| Do things to encourage predator/parasite build-up | Slightly | No | Yes | No | No | No | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Any soil, water, energy, or biodiversity conservation practices | Medium | Yes at low level | Yes | Slightly | Yes at low level | Yes at low level | |

Some of the beneficiary farmers, whether or not they understand the IPM philosophy fully, do know about, and use some GAP and IPM tools and tactics. The information in this table shows plenty of room for improvement and use of additional tools and techniques. Beyond this, Annex 1 shows a Crop-Pest-IPM-Pesticide matrix for each crop to be assisted by Pakistan assistance projects, most major pests of each crop, and a list of tools and tactics used for the same pests in developed countries, and recommended for trial and adoption.

**Food Security/Fumigation of Warehouses**

Unfortunately no integrated storage network exists in Pakistan, resulting in huge post-harvest losses at this stage. In case of grain crops numbers of factors are responsible for loss during storage including evaporation and absorption of moisture by grain, temperature, rainfall, insects, rodents, birds, molds, condition of grain at the time of storage and length of storage period. Of all these, the major loss causing agents are the insects and their attack is directly related to moisture content and type of storage structure. Generally in bins and house type godowns, the incidence of pest attack is roughly 1-2 per cent.

In godowns owned by the commission agents or private dealers the damage varies from 5-15 per cent. The insect pest attack vary from 0-18 per cent in wheat, 1.6 to 7 per cent in rice, 1 to 10 per cent in pulses and 2 to 10 per cent in maize sorghum and millet depending upon the type of storage (bulk or bag), whether treated or untreated and on the period of storage (Qamar 1998). In private store houses anti sprouting chemicals such as maleic hydrazide, chlorpropham/CIPC and nonyl alcohol are used on potatoes for better shelf life. Fumigation is also done to manage insect and rodents before and even during storages.

IPM is present through sanitation of the warehouse. Sanitation is the primary non-pesticide tactic that will prevent and keep pest populations under control so they do not require treating with pesticides, or require fewer treatments. Several sanitation best practices, tools and tactics for pests of cereals, small grains and dry beans/peas are included in Annex 1. Following that, Annex 7 contains chemicals (identified by a “W” for warehouse in column 3) that are commonly used for treating warehouses, either via fumigation with gasses, spraying with other chemicals or procurement and use of rodenticides in bait boxes. Methyl bromide is being phased out internationally, due to its impact on the earth’s ozone layer, and must not be used on any USAID project.

Surveys show that the following warehouse IPM tools and tactics are used in Pakistan:

- Sanitation/Cleaning up of all residues
- Good aeration of commodities
- Multiple management tactics are combined
- Fumigant applicators are trained and certified
- Use of sophisticated Personal Protection Equipment for fumigant use
- Use of fumigant-specific chemical meters for fumigant levels detection

Areas that can use improvement include sanitation, routine monitoring, risk benefit analyses, accurate pest identification and knowledge of stored product biology, ecology and behavior.

### Veterinary Livestock Treatments

Livestock veterinary pesticides, marked with a “V” in Annex 7, column 3, can be integrated with other tactics including: hand-picking ticks, fly baits, disease vaccines, using natural extracts of Camphor, as well as the Euphorb (*Euphorbia candelabrum*) milky latex against ticks, Solanaceous (*Solanum incanum*) alkaloid extracts against ticks, and neem leaf aqueous extracts against endoparasites. Other shrub and tree gums, resins and salts can be rubbed on animals to repel ticks.

### Water and Sanitation

Integrated Pest Management per se does not necessarily apply to water and sanitation. However, best practices do apply, and there are non-chemical means to disinfect or sanitize water. These include the use of ultraviolet radiation, solar treatment and membrane filtration. Other techniques include those based on mechanical and biological processes, as follows[55]:

- mechanical systems: sand filtration, lava filter systems and systems based on UV-radiation
- biological systems including plant systems as constructed wetlands and treatment ponds (sometimes incorrectly called reed beds and living walls) and
- biological systems including compact systems as activated sludge systems, biorotators, aerobic biofilters and anaerobic biofilters, submerged aerated filters, and biorolls

In order to purify the water adequately, several of these systems are usually combined to work as a whole. Combination of the systems is done in two to three stages, namely primary and secondary purification. Sometimes tertiary purification is also added.

### Avian Influenza/Disinfectants and Sanitizers

The international—as well as many national—strategies being implemented to deal with HPAI already form an integrated program. In addition to control of the HPAI virus, most initiatives include monitoring and surveillance, zoning and compartmentalization, regulations and quarantine, vaccination, disinfection and disposal of waste[56].

### Health/Malaria/Dengue

USAID’s PEA[57] for malaria control contains numerous IVM tactics that can be used in concert with pesticides for mosquito control. Future USAID projects that work on malaria must follow the PEA. IVM tactics include:

Interventions targeting adult mosquitoes

- Use of screens on home windows and doors to exclude mosquitoes.
- IRS using WHO-recommended pesticides.
- Insecticide-treated nets (ITNs).

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[55] http://en.wikipedia.org/wiki/Water_purification#Other_mechanical_and_biological_techniques
[56] http://www.oie.int/animal-health-in-the-world/web-portal-on-avian-influenza/
[57] http://pdf.usaid.gov/pdf_docs/PNADI081.pdf (note that a new updated IVM PEA is being drafted in 2011)

Interventions targeting mosquito larvae

- Environmental management methods, including filling breeding sites, lining water sources and canals, physical wetland drainage, biological wetland drainage, impoundment planning, deepening and narrowing of old drains, vegetation manipulation, synchronized cropping and intermittent irrigation, larvivorous fish introduction, and saltwater flooding.
- Larvicidal agents, including bacterial larvicides, methoprene, temephos, and molecular films and oils.

**Construction**

IPM applies to both malarial and dengue mosquito control, discussed above, and termite control. IPM measures for termite control are included at the end of Annex 1.

**Rights of Way**

Weeds on Rights of Way can be mowed in addition to treated with herbicides.

Recommendations for Mitigation

- USAID Pakistan project field staff assist with the production of sector and crop-specific Production and Pest Management Plans (PPMPs), using the attached Annex 1 containing Crop-Pest-IPM-Pesticide suggestions for all major pests on all crops/livestock/other, organized by crop phenology or seasonality, and developed into field technical flyers or posters.
- During training and field visits by Pakistan assistance projects field staff, enhance understanding of, and emphasis on, IPM/IVM philosophy, tools and techniques for each crop-pest combination, with synthetic pesticide use as a last resort and choice of least toxic alternatives.

## 3.4 Factor D: Proposed Method or Methods of Application, Including the Availability of Application and Safety Equipment

This section examines how the pesticides are to be applied, to understand specific risks with different application equipment available and application methodologies, and the measures to be taken (repeated training especially of younger future farmers, and use of PPE) to ensure safe use for each application type. Pesticides can and do enter the body through the nose and mouth as vapors, through the skin and eyes by leaky sprayers, mixing spillage/splashing and spray drift, and mouth by accidental splashing or ingestion on food or cigarettes.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that most smallholder agriculture project beneficiaries on the FIRM project as well as health care workers on the Women's Hostel project use hand-pump (piston or diaphragm) backpack sprayer with wand. Orchard farmers on the FIRM project use truck- or tractor-mounted boom sprayers & motorized backpack sprayers. For weed control on dams, like in Balochistan, both hand-pump (piston or diaphragm) backpack sprayer with wand, portable tank/pump/hose/lance unit.*

*The Water and Sanitation sector, through Jacobabad Water, Wastewater and Solid Waste Infrastructure, uses portable tank/pump/hose/lance unit. Construction projects like the Sindh Basic Education Program (SBEP) and Municipal Services Program use a portable tank/pump/hose/lance unit to apply termiticides, whereas some other projects use a simple hand-pump (piston or diaphragm) backpack sprayer with wand or motorized backpack sprayer.*

### Agriculture Seed Treatment

Typical pesticides and chemicals used for treating seed in Pakistan are listed above under Section 2.4. Ideally, seed would be treated in a specialized "seed treater" composed of a mixing tank, treater head and coating chamber to apply precisely measured quantities of pesticide. However, most farmers are mixing the seed and pesticide in buckets, wheelbarrows or other large receptacles, which leads to uneven application and coverage of seed. Gloves must be used for seed mixing and handling.

### Field Crops

Although there are a wide variety of crops included under the cropping systems of the Pakistan, many small- and medium-holder vegetable farmers still use hand-pump and motorized backpack sprayers with hand-held lances for application, which are prone to leaks at parts junctions and thus applicator exposure risk. Some orchards and plantations use tractor-drawn orchard air-blast, vertical and horizontal boom sprayers, as well as fixed mixing tank and pump sprayers with long hoses attached to hand-operated application lances. Some farmers with more complex application equipment keep hand-pump backpack sprayers for limited 'spot' applications of specific chemicals such as herbicides for areas missed by boom applications.

USAID's FATA-LDP program delivered 210 spray pumps to farmers. In 2012, USAID Paksitan gave date farming Small and Medium Enterprises (SMEs) motorized boom sprayers, among other materials[58].

Although most Pakistan farmers do not generally use PPE, Pakistan assistance projects-supported beneficiaries will be promoting their use as a best practice. Pesticide labels should provide guidance on appropriate PPE to use, and EPA has guidance on a website[59].

### Greenhouse/Nursery Crops

Most project pesticides to be used in greenhouses will be applied by hand-pumped backpack sprayers (liquids) or a few by hand (powders and granules). Although most Pakistan farmers do not use PPE, Pakistan assistance projects-supported beneficiaries will be promoting their use as a best practice. Pesticide labels should provide guidance on appropriate PPE to use, and the EPA website noted above can be referenced.

### Food Security/Warehouses

Warehouses are treated primarily by use of solid tablets that produce toxic gas once exposed to air and humidity, or by gasses directly. Fumigation, only if done only by a trained and equipped fumigation service, and not by USAID project-supported farmers (*absolutely requires two trained and certified-level fumigators for each fumigation event*):

- Use a continuous monitoring and detection program to check for and ID pests
- In the USA, "persons who are not trained and certified for the use of grain fumigants must not attempt to fumigate stored grain"
- Follow the aluminum phosphide label to determine correct amount of chemical to use per cubic meter of infested food commodity
- Calm warm day with no wind and temperature above 16 degrees (and not less than 4 degrees) Celsius
- Learn & follow all safety regulations

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58 https://www.flickr.com/photos/usaid_pakistan/7702801658/

59 http://www.epa.gov/oppfead1/safety/workers/equip.htm

- Have *two trained people* present for safety
- Plan to finish fumigation in 15-20 minutes maximum
- Post warning signs on all doors
- Use tape and 4 ml polyethylene sheeting
- Leave only necessary holes for putting aluminum phosphide tablets or gas from gas generator and quickly sealing them
- If using tablets, use probes to put tablets around (not in) grain sacks and pallets
- Remove webbing if Indian meal moth larvae are present
- Use proper respiratory protection equipment (self-contained oxygen or canister filter) for *both* fumigators
- Use phosphine gas detection devices
- Absolutely no phosphine tablets or residues come into direct contact with wheat flour

Other pesticide applications are by hand-pumped backpack sprayers (liquids) or a few by hand (powders). Rodenticides must be applied in closed bait boxes with visible warnings. See reference above for selection of appropriate PPE.

### Veterinary

Many ranchers and herders apply acaricides using backpack sprayers and some use a rag soaked in pesticides and applied using bare hands. These livestock farmers must be encouraged to keep and use chemical-resistant gloves for these purposes. Some ranchers and herders use dip-baths for livestock have fallen out of use and favor. See reference above for selection of appropriate PPE.

### Water and Sanitation

Drinking water sanitizers are generally applied by a water treatment facility. Best practices for handling, applying and reducing risks from water sanitizers are found through the Asian Development Bank[60].

### Avian Influenza/Disinfectants and Sanitizers

Annex 7 contains microbicides registered for use in Pakistan for disinfecting water and for use in HPAI, and identified with a "D" for disinfectant in column 3. Most disinfectants are Class I toxins and are extremely corrosive to eyes, skin and mucous membranes, especially necessitating the use of goggles or eye protection, chemical-resistant gloves, a carbon-filter respirator and a spray suit to protect clothing and skin. For this reason, most microbicides/disinfectants are shaded yellow for caution. For water treatment, water is exposed to a disinfectant while it is pumped through a treatment facility. Disinfectants for Avian Influenza are often applied by bucket and mop or hand brush.

The best information on how to apply the disinfectants safely will be found on the product or container labels. In the USA, EPA requires that all products have labels containing application and safety procedures. For products that are registered in the USA, use http://oaspub.epa.gov/pestlabl/ppls.home to see web copies of the labels. Products not registered in the USA are also likely to have labels with the same type of information, as most international standards require.

### Health/Malaria/Dengue

USAID has produced Programmatic Environmental Assessments to guide safe malaria mosquito control including IRS[61] and ITNs[62]. Most of the recommendations also apply to dengue prevention. IRS is

[60] http://www.adb.org/Evaluation/case-studies/2006-AER/Best-Practices-WaterSupply-Sanitation.pdf

accomplished using backpack sprayers with wands. Most IRS application staff members are required to wear PPE in order to do, and keep, their jobs. If LLITNs are used, then there will be no need to re-treat bed nets with pesticides. If only ITNs are available, then only WHO-trained and certified individuals with recommended PPE must do retreatment. Area spraying using large vehicles and fogging equipment to kill mosquitoes has fallen out of use, due to risks and pesticide waste.

#### Construction

Pesticides applied to standing water to control malarial and dengue mosquitoes and to building foundations to control termites are applied by backpack sprayers and impregnated granules. Respirators and gloves must be used.

#### Rights of Way

Herbicides applied to strips of grass and brush along public infrastructure are applied by truck-mounted boom sprayers.

### Issue: Leaky back-pack sprayers

Hand-pump backpack sprayers, used by the poorest farmers among others, can and do eventually develop leaks at almost every junction (filler cap, pump handle entry, exit hose attachment, lance attachment to the hose and at the lance handle) and these leaks soak into exposed skin. Clothing serves to wick and hold these pesticides in contact with skin, and to concentrate them use after use, until washed.

#### Recommendations for Mitigation

- Pakistan USAID assistance projects, especially those dealing with agriculture, as part of its provision of inputs, should include budget allocations for repair and maintenance of application equipment, and develop a management program that includes oversight of repair and maintenance by a selected member of a farmer cooperative or association.

### Issue: Pesticide granules and powders applied by hand

Most farmers that use pesticides formulated as granules or powders apply these by hand, without benefit of gloves. Gloves must be used for these applications, especially granules, as these are often highly toxic chemicals like carbofuran (which must not be used by Pakistan assistance project farmers unless glove use can be assured).

#### Recommendations for Mitigation

- Pakistan USAID assistance projects ensure that farmers that use powders or granules do so only with gloves.

### Issue: Pakistan farmers do not use PPE

Reasons that many Pakistan farmers do not use PPE to reduce pesticide exposure risks include:

[61] http://pdf.usaid.gov/pdf_docs/PNADI081.pdf
[62] http://pdf.usaid.gov/pdf_docs/PNACP696.pdf

1. Farmers and workers either discredit or do not completely understand the potential health risks associated with pesticides. Since they have not associated health problems with pesticide exposure they continue to take risks;
2. Climatic conditions (particularly heat) make it uncomfortable to use the safety equipment (despite the fact that it is recommended that many pesticides should be applied very early in the morning or later afternoon when it is cool and there is a lack of wind and rain);
3. Appropriate PPE (especially carbon cartridge respirators necessary for filtering organic chemical vapors) equipment is generally not available at all and if it is available, it is too expensive;
4. Farmers may not understand either the warning labels or pictograms provided on the pesticide labels.

Most pesticide containers, on each pesticide label, either list or put pictograms showing PPE that is recommended for use of that certain product.

### Recommendations for Mitigation

- Training under Pakistan assistance projects must include descriptions of health risks to spray operators, their families, and their village (see risks for each pesticide AI in Annex 7).
- Training must include advice on minimizing discomfort from wearing PPE, like spraying in late in the afternoon or evening.
- Ensure that (i.e., budget for) protective clothing (carbon-filter respirator mask, gloves, frequently-washed long-sleeved shirt and pants or Tyvec outfit, boots, and goggles if indicated on the label) recommended for the most commonly-used pesticides are available to farmers and farm workers involved with pesticide use. General examples of PPE to be used for different types of pesticide are found in the following website: http://www.epa.gov/oppfead1/safety/workers/equip.htm.
- Provide training on the need for exclusion times and zones for areas that are being or have been sprayed. Include information about sensitive populations (pregnant women, children, elderly and sick).
- Put into place sprayer equipment maintenance procedures, proper spray techniques that reduce sprayed area walk-through, as well as frequent washing of application clothing.
- Considering illiteracy issues, training must use and explain pictogram representations. Some general mitigation measures to ensure safe pesticide use are contained in Chapter 13 of the following website: http://pdf.usaid.gov/pdf_docs/PNADK154.pdf.
- Set out a schedule for, and budget for, repeated training in safe handling and use of pesticides – including aspects such as types and classes of pesticides, human and environmental risk associated with pesticides, use and maintenance of PPE, understanding information on labels and proper disposal of packaging. Ensure that training 'sticks' by developing a system to certify trained farmers for safe use.

## 3.5 Factor E: Any Acute and Long-Term Toxicological Hazards, Either Human or Environmental, Associated with the Proposed Use, and Measures Available to Minimize Such Hazards

This section of the PERSUAP examines the acute and chronic toxicological risks associated with the proposed pesticides.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that none of the projects knew of any accidental human pesticide poisonings, or kills of fish, birds, honeybees or wildlife.*

The pesticide matrix in Annex 7, columns 6, 7 and 8 contain information on acute and chronic human toxicological risks for every pesticide AIs found in Pakistan, or likely to be imported to or used in all seven of the sectors that this PERSUAP covers. And, column 9 contains information on the potential for each AI to pollute ground (drinking) water. With a couple of exceptions, USAID projects must not permit the procurement and use of pesticides in Annex 7 containing AIs that are WHO Classes Ia or Ib, EPA Class I, or known to be carcinogens or water pollutants, marked in red, and should only cautiously, with additional research, permit those shaded in yellow.

Annex 7, columns 10-18, contains information on relative eco-toxicity, if known, of each AI to several important terrestrial and aquatic organisms. USAID-supported projects must make pesticide choice decisions biased toward those pesticides with lower human and environmental risks. Nevertheless, pesticides are poisons, and nearly all of them present acute and/or long-term toxicological hazards, especially if they are used incorrectly.

### Issue: Pesticide Active Ingredients on POPs and PIC lists

The Stockholm Convention on Persistent Organic Pollutants (POPs) and Rotterdam Convention's Prior Informed Consent (PIC) procedure which list banned and highly regulated toxic chemicals, respectively, were not known when Regulation 216 was written, so there is no language directly governing their procurement and use on USAID projects. Nevertheless, they present high risks to users and the environment, due to persistence and toxicity. It is thus prudent that they be discussed. Pakistan signed the POPs treaty on December 6, 2001 and ratified it on April 17, 2008. Pakistan ratified the PIC treaty on July 14, 2005.

The following websites contain current lists of all POPs and PIC chemicals: http://www.pic.int; http://www.pops.int. Endosulfan, which has been regulated (June 2010) for phase out and ban in the USA, and which was added to the POPs list in 2011, is finally banned for use in Pakistan, even though some likely still enters through informal (illegal) channels from India, a major producer of endosulfan. USAID Pakistan projects must not permit endosulfan to be purchased or used.

The Montreal Protocol, described on http://www.epa.gov/ozone/intpol/ finds the soil and warehouse fumigation chemical methyl bromide slated for phase out internationally and in the USA[63]. USAID Pakistan projects must not permit methyl bromide to be purchased or used.

#### Recommendations for Mitigation

- These POPs or PIC chemicals, listed on the POPs and PIC websites, including endosulfan, or methyl bromide, must not be used on Pakistan assistance projects beneficiary demonstration farms.

### Issue: Very high acute toxicity

A few of the pesticides found in Pakistan contain active ingredients that are EPA Class I or WHO Class Ia or Ib (the highest toxicities by mg/kg of body weight), which are *too toxic for small- and medium-scale (USAID's target), unaware and uninformed farmers to use*. These very highly acutely toxic pesticide AIs are found highlighted in red color in Annex 7. Less toxic alternatives, including preventive tactics and tools (Annex 1), and several curative pesticide choices, including some that are less toxic than Class I chemicals (Classes II, III and IV for instance), also found in Annex 1, exist, and should thus be used in place of Class I pesticides.

[63] http://www.epa.gov/ozone/mbr/; http://mbao.org/mbrqa.html#q6

### Recommendations for Mitigation

- With the exception of rodenticides and aluminum phosphide used by trained experts, Pakistan assistance project's beneficiaries must not procure and use products containing active ingredients that are WHO Class 1a or 1b, or EPA Class I acute toxicity (see Annex 7, red color shading).

## Issue: Moderate acute toxicity

All pesticide products that have at least acute WHO and EPA toxicity ratings of II (see Annex 7) are considered to be *too toxic for use without farmer training and proper use of PPE*.

### Recommendations for Mitigation

- Products containing active ingredients with Classes III or IV acute toxicity ratings must be recommended in place of Class II pesticides (see Annex 7).
- Moreover, recommendations must not be made to use such products unless it can be ascertained that appropriate training and PPE are available *and will be used*.

### Recommendations for Mitigation of Human Toxicological Exposures

Most pesticide poisonings result from careless handling practices or from a lack of knowledge regarding the safer handling of pesticides. Pesticides can enter the body in four major ways: through the skin, the mouth, the nose, and the eyes. Chapter 13 in the resource http://pdf.usaid.gov/pdf_docs/PNADK154.pdf contains measures to reduce risks of exposure via oral, dermal, respiratory and eyes. The time spent learning about safer procedures and how to use them is an investment in the health and safety of oneself, one's family, and others.

- Pakistan assistance projects field staff must encourage the demonstration farmers and beneficiaries with whom they work as partners to not procure or use POPs or PIC products or products containing very highly toxic active ingredients.
- Train beneficiaries and provide posters/flyers on pesticide safe-use BMPs. For each group of farmers to be trained, identify the pesticides most likely to be used on their specific crops, and then identify the human health risks associated with each by using information on pesticide labels, in the attached Annex 7, and on MSDSs.
- Provide training on, and follow basic first aid for pesticide overexposure. Train managers and farmers on basic pesticide overexposure first aid, while following recommendations found in Chapter 13 of http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, as well as any special first aid information included on labels and MSDSs for commonly-used pesticides.

### Recommendations for Mitigation of Exposures to Environmental Resources

Ecotoxicological exposures can be mitigated by adhering to the following do's and don'ts:

**Do's**

- Emphasize and use IPM practices in crop production
- Read and follow pesticide label instructions
- Choose the pesticide least toxic to fish and wildlife (see Annex 7)
- Protect field borders, bodies of water and other non-crop habitats from pesticide
- Completely cover pesticide granules with soil, especially spilled granules at the ends of rows
- Minimize chemical spray drift by using low-pressure sprays and nozzles that produce large droplets, properly calibrating and maintaining spray equipment, and use of a drift-control agent

- Properly dispose of chemical containers (provide training on what this means locally)
- Maintain a 2.5 to 5 km buffer no-spray zone around national parks, water bodies or other protected areas
- Warn beekeepers of upcoming spray events so that they may move or protect their hives

**Don'ts**

- Do not spray over ponds and drainage ditches
- Never wash equipment or containers in streams or where rinse water could enter ponds or streams
- Do not use pesticides with potential or known groundwater risks near drinking water sources, or where the water table is less than 2 meters, and on sandy soils with high water tables
- Do not apply pesticides in protected parks
- Do not use aerial applications near sensitive habitats
- Do not spray when wind speeds are more than 13 to 16 kph
- Do not apply granular pesticides in fields known to be frequented by migratory waterfowl
- Do not apply insecticides from 10 am to 4 pm when honeybees are foraging; insecticides are best applied late in the afternoon when it is cooler (or at night) with no wind or rain, and when honeybees do not forage

## 3.6 Factor F: Effectiveness of the Requested Pesticide for the Proposed Use

This section of the PERSUAP requires information similar to that provided previously, but more specific to the actual conditions of application and product quality. This section considers the potential for use of low-quality generic products (such as many of those imported from China and a few from India) as well as the development of pest resistance to proposed pesticides, both of which will decrease effectiveness (efficacy). The issues and mitigations will be the same for all of the sectors covered.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that none of the projects knew of any pesticides that they propose or promote to their beneficiaries, or beneficiaries use, that have a record of showing signs of working less and less effectively over time.*

Annex 7, in column 2, provides the class or type of chemical in each pesticide AI in order for USAID project implementers to be able to recommend that farmers rotate among different classes of chemicals to counter the development of resistance by pests and diseases.

### Agriculture Seed Treatment, Field Crops and Greenhouse/Nursery Crops

Local knowledge is essential to choosing the correct pesticides. Local farmers know what has or has not worked for them in the past, and Pakistan assistance projects can increase local knowledge as to what is available, possibly effective, and presents the lowest risk.

Resistance of pests to pesticides used on Pakistan assistance projects crops will likely occur with increased pesticide use. Farmers in most countries over-dose and under-dose and use non-selective pesticides, all of which increases chances for resistance development. The primary tool in the battle against resistance is rotation by class or type among available chemicals (using information in Annex 7), combined with the use of preventive IPM tools and tactics.

### Food Security/Warehouses

Managing stored grain pest resistance to certain insecticides is a major challenge to this sector[64]. There are even insects that have developed resistance to deadly phosphine gas[65]. Most food security pesticide applicators trained by the UNWFP will know the insect, mite and other pest species that have developed resistance to certain pesticides or classes of pesticides. And, they will know the alternative effective pesticides available for rotation.

### Veterinary

Pathogen, insect and tick resistance to vaccines/antibiotics/medicines, insecticides and acaricides, respectively is a major challenge facing veterinary technicians. Fully 41% of pest resistance occurs in the veterinary field[66]. The primary tool in the battle against resistance is rotation among available chemicals (using information in Annex 7), combined with the use of preventive IVM tools and tactics.

### Water and Sanitation

Although microbial resistance to antibiotics like pharmaceuticals is well known, resistance by microbes to highly toxic disinfectants is rare. Furthermore, chlorine compounds used for treating water are highly effective and this is the reason that they continue to be used to the present time. These microbicides and disinfectants remain effective.

### Avian Influenza/Disinfectants

Fortunately, most disease-causing viruses have not developed resistance to most disinfectants. The HPAI virus is not omnipresent and thus is not continuously exposed to disinfectants to which it might develop some resistance. However, it is still a good idea to rotate disinfectants to reduce the chance of resistance.

### Health/Malaria/Dengue

Unfortunately, malarial mosquitoes are developing resistance to many of the insecticides used against them. Most WHO-trained malaria control technicians recognize the need to rotate among pesticide classes and products. The same applies for dengue transmitting mosquitoes, although they are in a different genus than malaria mosquitoes.

### Construction

Construction crews can gain advice on malaria and dengue control products and resistance from the local malaria control board. Many termiticides are relatively new. To reduce the development of resistance by termites to termiticides, mixes of termiticides can be used containing chemicals from different classes (see Annex 1).

### Rights of Way

To date, herbicide applications to rights of way have not shown high levels of resistance. In any case, herbicides must be rotated among classes to keep resistance development low.

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64 http://ipm.illinois.edu/pubs/iapmh/05chapter.pdf
65 http://bru.gmprc.ksu.edu/proj/iwcspp/pdf/9/kps41.pdf
66 http://science.jrank.org/pages/48691/Pesticide-Resistance.html

### Issue: Lack of knowledge and information on pesticide effectiveness

At some point, Pakistan assistance projects field staff and demonstration farmers may begin to note that some products no longer work well to control pests in their field, and will likely begin to blame pesticide manufacturers for a weaker product. This could be the development of insecticide resistance, and it could be the result of improper dosing. Farmers must be trained to monitor for the development of insecticide resistance, and Pakistan assistance projects implementers must be on the lookout for it during their field visits.

**Recommendations for Mitigation**

- Through training, Pakistan assistance projects field staff increase local knowledge on pesticides available, possibly effective, and present the lowest risk.
- Teach farmers and other beneficiaries to rotate pesticides to reduce the build-up of resistance.
- Monitor resistance by noting reduction in efficacy of each pesticide product.

## 3.7 Factor G: Compatibility of the Proposed Pesticide Use with Target and Non-Target Ecosystems

This section examines the potential effect of the pesticides on organisms other than the target pest (herein called critical resources). Non-target species of concern include fish, honeybees, birds, earthworms, aquatic organisms, and beneficial insects. The potential for negative impact on non-target species must be assessed and appropriate steps identified to mitigate adverse impacts; and this would be included in the Pakistan assistance projects' EMMP.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that none of the projects found instances of incompatibility of chosen pesticides for pests on which they were used.*

During 2012, USAID/Pakistan had a new FAA 118/119, Tropical Forest and Biodiversity Assessment, produced. It contains numerous references to natural resources at risk from various threats in Pakistan. Pesticides are mentioned 22 times in this report. The FAA report notes on p 35 that "Indiscriminate use of pesticides and herbicides, especially in the cotton, sugarcane, rice, and tobacco growing areas in the country, mainly impacting on the populations of gray and black partridges, raptors, and waterfowl" are one of the main risks to Threatened and Endangered Species (TES). Annex K of the FAA report lists over-use of pesticides as one of the unsustainable and poor natural resources practices.

Annex 7 of this PERSUAP shows, in columns 10-18, the relative known risks to the types of terrestrial and aquatic organisms referred to above for each pesticide active ingredient found in pesticide products discovered likely to be used in Pakistan in each of the seven sectors covered by this PERSUAP, so that informed product choices can be made if the pesticide is to be used in or near sensitive areas or resources. Maps below show natural resources.

### Issue: Forest resources, biodiversity conservation and protected or endangered species

**Forest resources in Pakistan**

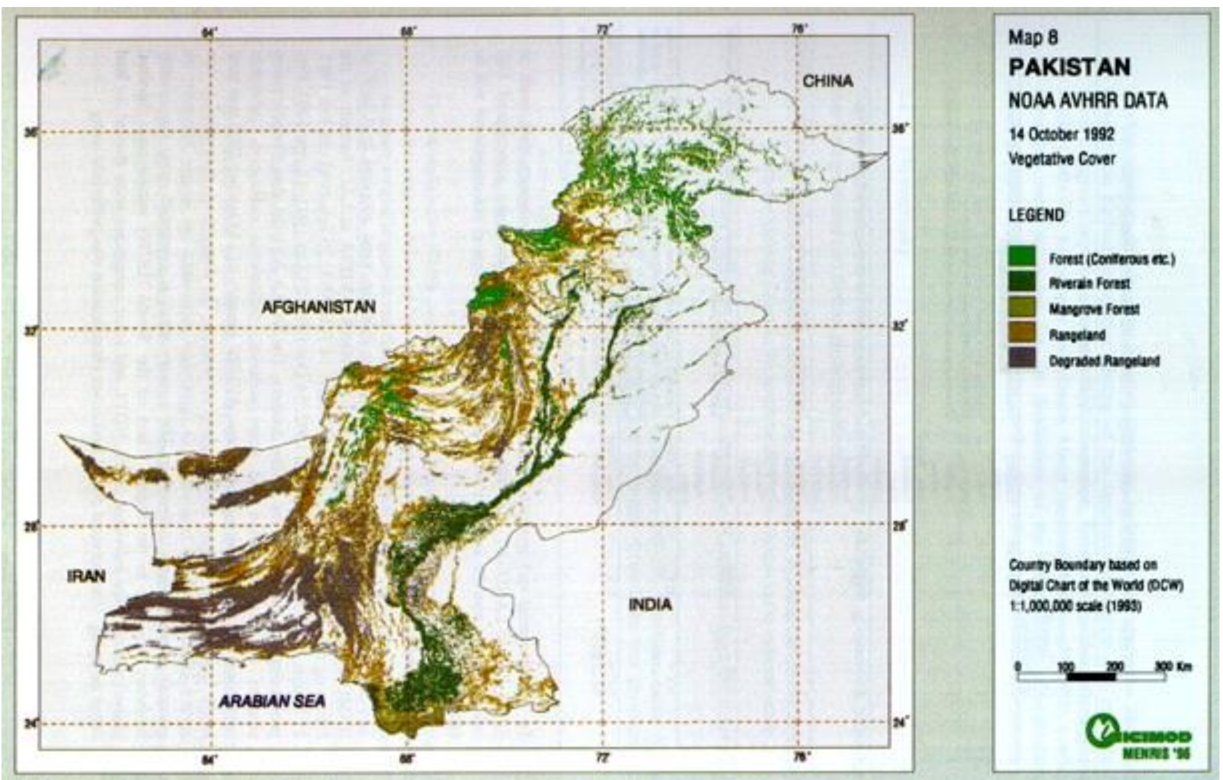
The following forest types are found in Pakistan[67]:

[67] http://www.wildlifeofpakistan.com/IntroductiontoPakistan/forestsofPakistan.htm

- Littoral and Swamp forests
- Tropical dry deciduous forests
- Tropical thorn forests
- Sub-tropical broad-leaved evergreen forests
- Sub-tropical pine forests
- Himalayan moist temperate forests
- Himalayan dry temperate forests
- Sub-alpine forests
- Alpine scrub

The figure below shows Pakistan vegetative cover, including forests. True forest cover follows rivers and mountain valleys, also with rivers and water. Unfortunately, forest resources are harvested for multiple purposes and these highly fertile lowland areas are planted with crops and treated with pesticides and synthetic fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).

**FIGURE 2: PAKISTAN VEGETATIVE COVER HIGHLIGHTING FORESTS (UNEP)**




USAID Pakistan projects must not permit the procurement and use of pesticides in or near (5km from) protected areas, parks forests, waterways or water bodies, wetlands or swamps.

### Pakistan Protected Areas

Below is a map of Pakistan protected areas.

There are three types of areas that have been declared as protected:

- National Parks

- Wildlife Sanctuaries
- Game Reserves

The National Parks are only meant for recreational purposes where no other activity can take place. In Wildlife Sanctuaries, no hunting is allowed as they have the endangered wildlife species. As for the Game Reserves, hunting is allowed but only in certain months in a year and after a hunting permit has been obtained from the Wildlife Department. In Pakistan, there are 225 protected areas composed of 14 National Parks, 99 Wildlife Sanctuaries and 96 Game Reserves. They occupy a large 10.4% of the land area (9,170,121 ha) of Pakistan.

### TABLE 12: SUMMARY OF PROTECTED AREAS (PAS) IN PAKISTAN (BASED ON PAKISTAN NCCW DATA)[68]

| Region/ Province | National Parks | Wildlife Sanctuaries | Game Reserves | Un-Classified | Total PAs | Total Area Conserved (ha) | % of Total Land Area Protected |
|---|---|---|---|---|---|---|---|
| Azad Jammu Kashmir | 1 | 0 | 8 | 0 | 9 | 51,998 | 3.91 |
| Balochistan | 2 | 15 | 7 | 7 | 31 | 1,837,704 | 5.29 |
| Punjab | 2 | 37 | 19 | 0 | 58 | 3,315,803 | 16.14 |
| NWFP | 3 | 6 | 38 | 5 | 52 | 470,675 | 6.30 |
| Sindh | 1 | 35 | 14 | 4 | 54 | 1,307,575 | 9.27 |
| Federal Territory | 1 | 1 | 1 | 0 | 3 | 94,186 | 100 |
| Northern Areas | 4 | 5 | 9 | 0 | 18 | 2,092,180 | 2.97 |
| **Totals** | **14** | **99** | **96** | **16** | **225** | **9,170,121** | **10.40** |

The first national park, Lal Suhanra, was formally declared in the Bahawalpur district of Punjab in 1972. The park consists of irrigated forest plantations (20,974 acres), desert branch pond (4780 acres) and Cholistan Desert (51726 acres) for a total of 77480 acres. The park was established to protect existing wildlife and vegetation; reintroduce extirpated species; rehabilitate wildlife habitat; create education/research facilities for local and foreign tourists, and recreational facilities for the local population.

## International Union for Conservation of Nature

The International Union for Conservation of Nature (IUCN) works to help Pakistan find pragmatic solutions to the most pressing environment and development challenges. IUCN is working to implement an Integrated Water Resources Management (IWRM) model in .

During 2013, IUCN worked to make the Juniper Forests of Ziarat the second declared Biosphere Reserve in Pakistan. The first is the lal Sohanara National Park situated in Bahawalpur District. IUCN, which has been working on sea turtle conservation since 2010, also recently conducted a rapid biodiversity assessment of the Ormara beach, in district Gwadar. Ormara beach is a coastal wetland with rich biodiversity and one of the largest sea turtle nesting beaches in Pakistan.

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[68] National Council for Conservation of Wildlife; http://www.wildlifeofpakistan.com/WildlifeBiodiversityofPakistan/protectedareassystemofPakistan.htm

Through the Sindh Coastal Communities Development Programme (SCCDP) from 2008 to 2013, IUCN has been contributing, in collaboration with the Sindh Forest Department and the Sindh Coastal Development Authority, towards the rehabilitation of degraded mangrove areas along the country's Indus Delta coastal belt in Sindh and Balochistan.

To ascertain the change in population of the rare and endangered of the wild Markhor mountain goat, IUCN conducted a survey in the Khalifat and Malikat mountain ranges of Ziarat in November 2013, in collaboration with the UN Educational, Scientific and Cultural Organization (UNESCO), the Balochistan Forest and Wildlife Department and local communities.

Kirthar National Park achieved its protected status in 1973. Established in the Dadu district of Sindh, this 466,000 acre reserve provides protection for a fine herd of ibex about 60 miles north of Karachi. Other large game species such as Indian gazelle and urial sheep have increased their populations within the park. A management plan has been drawn up for the park with the assistance of the IUCN. However, fiscal restraints and other priorities have largely precluded full implementation of the plan.

Khunjerab in northern Hunza, Gilgit Agency, became the third national park in 1975. This area has been successful in providing protection for the Marco Polo's sheep, blue sheep, snow leopard, snowcock, snow partridge and other high mountain species.

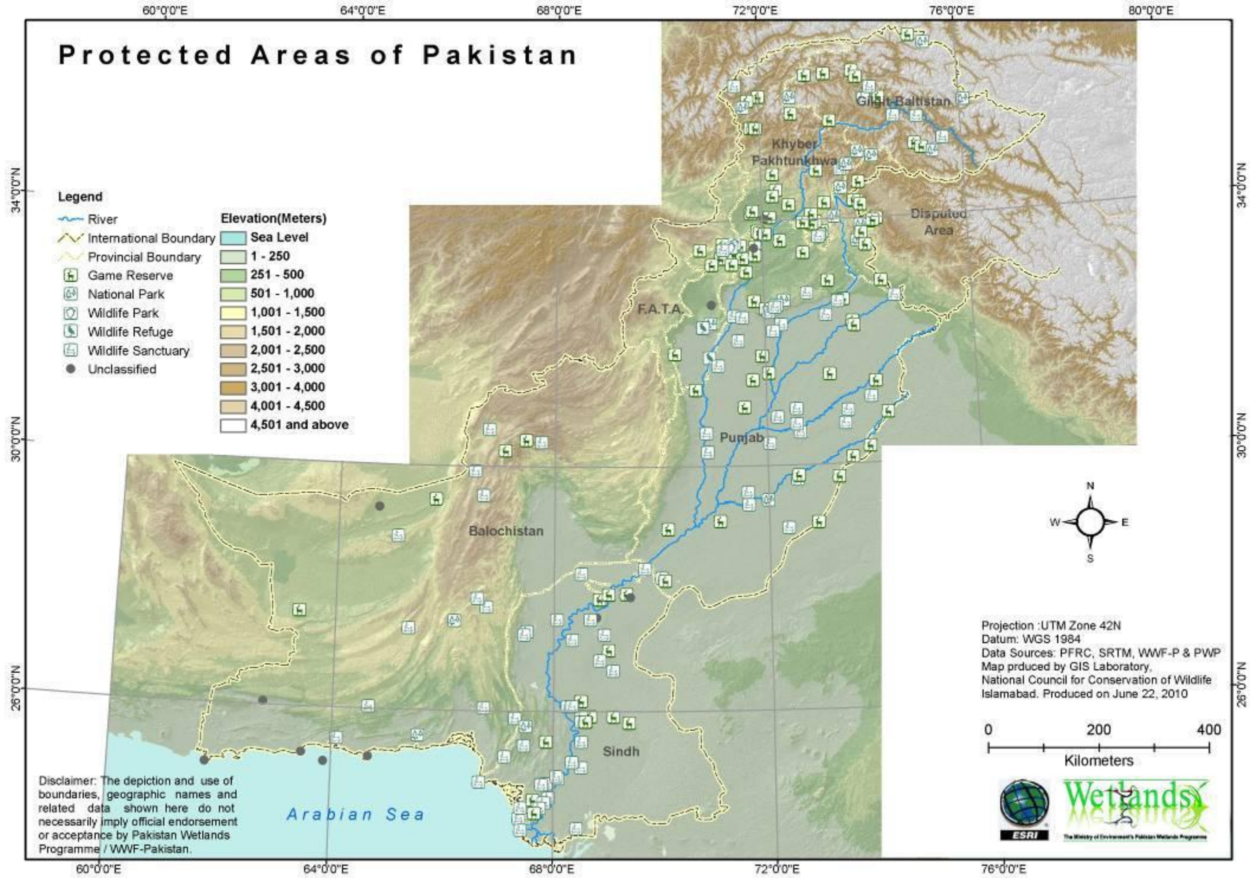
National parks in Pakistan have apparently been established primarily for wildlife and not necessarily for their historic or scenic features. Their administration is handled by the provincial wildlife departments. So far, 15 national parks have been declared.

### Ramsar Convention

The Ramsar Convention on Wetland protection was been signed in Ramsar, Iran in 1971. As of March 2013, there are nineteen Ramsar sites, covering an area of 1,343,627 hectares (3,320,170 acres) in Pakistan. Most of these are in Sindh and Balochistan. See a list of Ramsar sites in Pakistan at http://en.wikipedia.org/wiki/List_of_Ramsar_Wetland_sites_in_Pakistan.

USAID Pakistan projects must not permit the use of pesticides in or near (5km from) protected areas, parks, wildlife sanctuaries and preserves, forests, Ramsar wetlands, waterways or water bodies, wetlands or swamps.

**FIGURE 3: PROTECTED AREAS OF PAKISTAN**




## Pakistan Biodiversity

According to the World Wildlife Fund (WWF), the following represents the biodiversity present in Pakistan.

### Flora

About 5,500 - 6,000 species of vascular plants have been recorded in Pakistan including both native and introduced species. The flora included elements of the 6 phytogeographic regions. Four monotypic genera of flowering plants and around 400 (7.8%) species are endemic to Pakistan. Almost 80% of the endemics are found in the northern and western mountains. The Kashmir Himalayas are identified as a global center of plant diversity and endemism. Families with more than 20 recorded endemics are Papilionaceae (57 species), Compositae (49), Umbelliferae (34), Poaceae (32) and Brassicaceae (20).

### Mammals

Around 174 mammal species have been reported in Pakistan. Out of these, there are at least 3 endemic species and a number of endemic and near endemic sub-species.

### Birds

Six hundred and sixty eight bird species have been recorded in Pakistan. Out of them, 375 were recorded as breeding. Breeding birds are a mixture of Palearctic and Indomalayan forms (one-third) and the occurrence of many species at one or the other geographical limits of their range shows the diverse origins of the avifauna. The Sulaiman Range, the Hindu Kush, and the Himalayas in the NWFP and Azad Kashmir comprise part of the Western Himalayan Endemic Bird Area; this is the global center of bird endemism. The Indus Valley wetlands are the second area of endemism.

### Reptiles/Amphibians

Around 177 species or reptiles and amphibians, being a blend of Palearctic and Indomalayan forms, are found in Pakistan. Out of the total 14 species of turtles, 90 of lizards and 65 of snakes have been reported. Thirteen species are believed to be endemic. Being a semi-arid country, only 22 species of amphibians have been recorded, of which 9 are endemic.

### Fish

Pakistan has 198 native and introduced freshwater fish species. The fish fauna is predominately south Asian and with some west Asian and high Asian elements. Fish species diversity is highest in the Indus river plains and in adjacent hill ranges (Kirthar Range), and in the Himalayan foothills in Hazara, Malakand, Swat and Peshawar. Diversity is lowest in the mountain zone of the northern mountains and arid parts of north-west Baluchistan. There are 29 endemic species.

### Invertebrates

There has been little research on Invertebrates of Pakistan. About 5,000 species of invertebrates have been recorded including insects (1,000 species of true bugs, 400 species of butterflies and moths, 110 species of flies and 49 species of termites). Others include 109 species of marine worms, over 800 species of mollusks and 355 species of nematodes.

One large biodiversity "hotspot" includes the Himalaya Range Hotspot, as shown below. Any projects operating within this range in Pakistan must limit pesticide procurement and use, and use the pesticides with the lowest toxicities to organisms shown in Annex 7, columns 10-18.

**FIGURE 4: HIMALAYA HOTSPOT[69]**


[69] http://www.biodiversityhotspots.org/xp/hotspots/himalaya/Pages/default.aspx

### Issue: Pesticide Persistence

The effect of each pesticide on non-target ecosystems will depend on how long it stays in the environment, or rather its rate of break-down, or half-life. Half-life is defined as the time (in days, weeks or years) required for half of the pesticide present after an application to break down into degradation products. The rate of pesticide breakdown depends on a variety of factors including temperature, soil pH, soil microbe content and whether or not the pesticide is exposed to light, water, and oxygen.

Many pesticide breakdown products are themselves toxic, and each may also have a significant half-life. Since pesticides break down with exposure to soil microbes and natural chemicals, sunlight and water, there are half-lives for exposure to each of these factors.

In the soil, types and numbers of microbes present, water, oxygen, temperature, pH, and soil type (sand, clay, loam) all affect the rate of breakdown. Most pesticides also break down, or photo-degrade, with exposure to light, especially ultraviolet rays. Lastly, pesticides can be broken down, or hydrolyzed, with exposure to water. Pesticides with a long residual period (that are labeled persistent and last for years) include atrazine herbicide and organochlorine pesticides. Many of the newer carbamate, organophosphate and synthetic pyrethroid pesticides break down much quicker, generally within weeks, in the environment.

#### Recommendations for Mitigation

- Consider the toxicity, half-life and breakdown products of pesticides during the selection process, and choose pesticides that are less toxic and break down quickly in the environment.
- Avoid using pesticides in or within a 2km buffer zone from protected areas or national parks and where endangered species are known to exist.
- If agricultural production is done within 10km up-wind or up-stream from a protected area, investigate the use of botanical and biological controls, as practical, or produce Organic crops near these valuable natural resources.
- Apply pesticides early in the morning before honeybees forage. Do not apply during heavy rains or winds. Follow instructions on pesticide packaging.
- Apply pesticides at least 35 meters from open water.

## 3.8 Factor H: Conditions under which the Pesticide is to be Used, Including Climate, Geography, Hydrology, and Soils

In general, in addition to element G above, this requirement attempts to protect natural resources from the dangers of pesticide misuse and contamination, especially of groundwater resources. The following conditions apply, regardless of pesticide use sector, and thus the information here covers all seven sectors.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that few of the projects had databases of conditions for pesticide use and two projects, the Agribusiness Project in agriculture, and the Balochistan Agriculture Project use such information contained in PERSUAPs to guide them.*

### Pakistan Climate

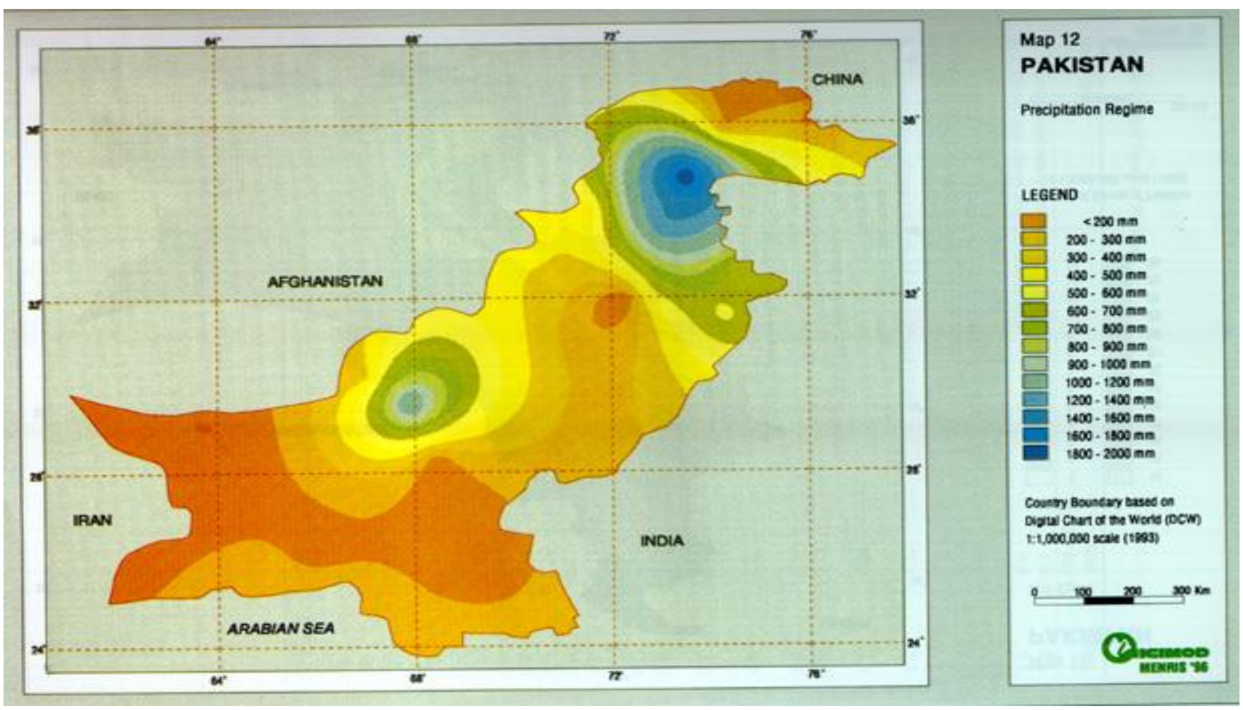
Depending on the topography, there is an extreme variation in the temperature of Pakistan. The country is essentially arid except for the southern slopes of the Himalayas and the sub-mountainous tract where the annual rainfall varies between 760 and 1270 mm. This area has humid sub-Tropical climate. In the extreme north - because of great heights - Highland climate prevails. The controlling factors of the climate are:

1. The sub-Tropical location of Pakistan that tends to keep the temperature high, particularly in summer.
2. The oceanic influence of the Arabian Sea that keeps down the temperature contrast between summer and winter at the coast.
3. Higher altitudes in the west and north that keep the temperature down throughout the year.
4. The Monsoon winds that bring rainfall in summer.
5. The Western Depression originating from the Mediterranean region and entering Pakistan from the west that brings rainfall in winter. These cyclones make a long land journey and are thus robbed of most of the moisture by the time they reach Pakistan.
6. A temperature inversion layer at a low elevation of about 1,500 m in the south during the summer, which does not allow the moisture-laden air to rise and condensation to take place.

## Pakistan Rainfall

The major part of Pakistan experiences dry climate. Humid conditions prevail but over a small area in the north. The whole of Sindh, most of Baluchistan, the major part of the Punjab and central parts of Northern Areas receive less than 250 mm of rainfall in a year. Northern Sindh, southern Punjab, north-western Baluchistan and the central parts of Northern Areas receive less than 125 mm of rainfall. True humid conditions appear after the rainfall increases to 750 mm in plains and 625 mm in highlands.  The figure below shows the precipitation patterns in Pakistan.

**FIGURE 5:  PRECIPITATION PATTERNS IN PAKISTAN (UNEP)**




## Pakistan Land Use

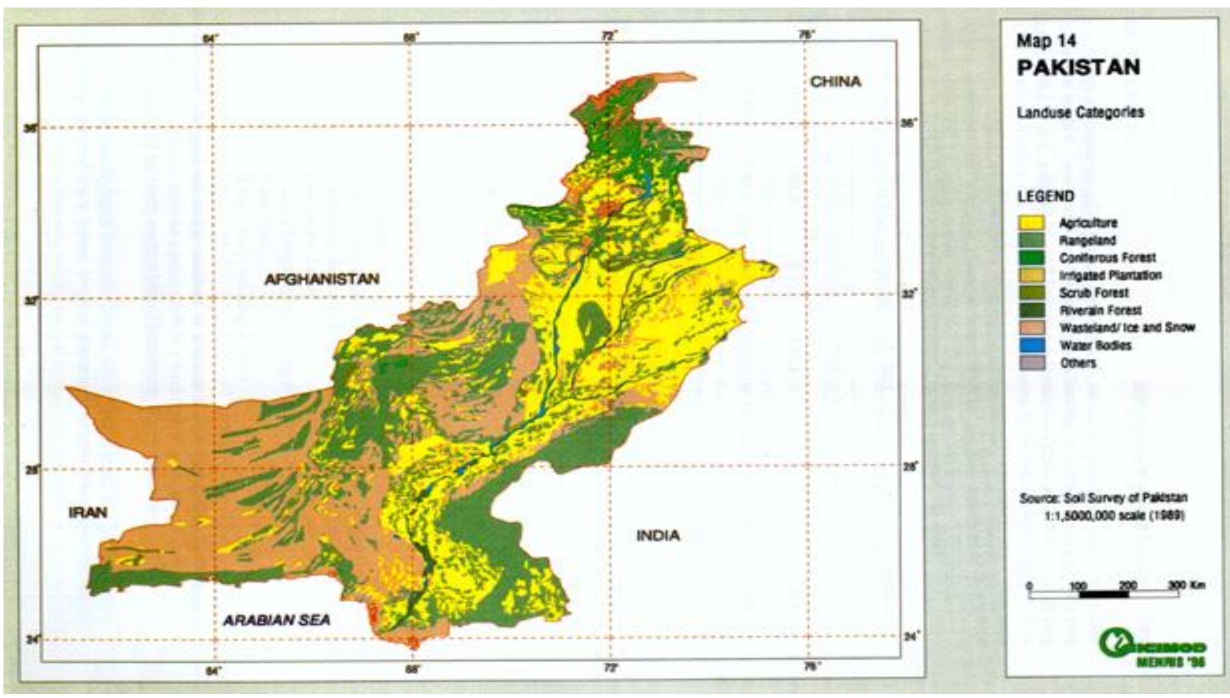
For the purpose of this study, the land area of Pakistan can be divided into five major categories: Reported Area; Forest Area; Cropped Area, Cultivable Waste; Unreported Area. The data, though dated, and in need of an update to the 2000s, has a time interval of 46 years: sufficient to determine the changed land use pattern, if any.

### TABLE 13: LAND USE PATTERN OF PAKISTAN (MILLION HA)

| Category | 1947-48 | 1993-94 | % Change |
|---|---|---|---|
| Geographical Area | 79.61 | 79.61 | 0.00 |
| Reported Area | 47.43 | 58.12 | + 7.79 |
| Forest Area | 2.84 | 3.44 | + 21.13 |
| Cropped Area | 14.60 | 22.15 | + 22.92 |
| Cultivable Waste | 11.50 | 8.84 | - 16.84 |
| Unreported Area | 32.18 | 21.49 | - 16.35 |

The figure below presents the Land use Categories for the four provinces of Pakistan. Compared to the data provided by the Forest and Agriculture Departments, the data of Soil Survey Department differs in almost all the land use categories. This warrants a serious re-classification of the present land use status.

### FIGURE 6: MAP OF LAND USE PATTERNS IN PAKISTAN




As seen in the figure above, most of the commercial agriculture (cotton, wheat and rice) in Pakistan is concentrated along the eastern edge and following the Indus River Valley. Primary land use changes—deforestation, followed by agriculture expansion—occur in the high altitude Hindu-Kush Himalayan region areas of the northwest, near Swat District[70] and Abbottabad District[71].

According to a map prepared by the Soil Survey of Pakistan (published in 1988), nine major land use classes have been identified, as identified in the Table below.

[70] http://link.springer.com/article/10.1007%2Fs10113-012-0395-1
[71] http://shahidraza.info/pdf/ESDev.pdf

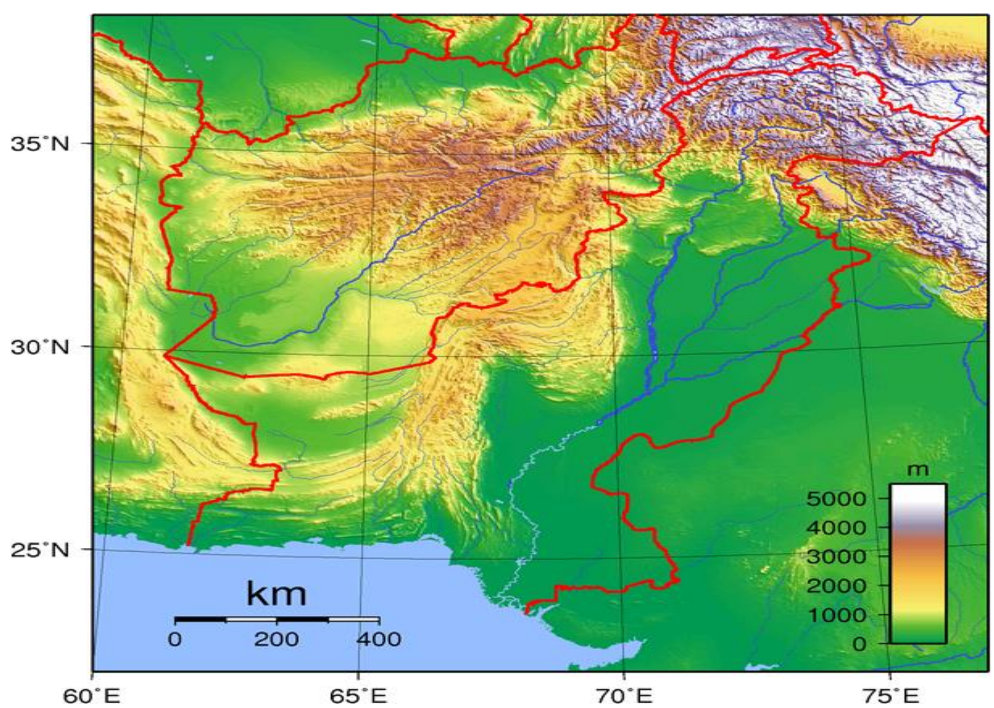
### TABLE 14: LAND USE CATEGORIES OF PAKISTAN (000' HA)

| Land Use Type | Area | Percentage |
|---|---|---|
| 1. Agriculture | 21,733 | 27.3 |
| 2. Rangelands | 25,475 | 32.0 |
| 3. Coniferous Forests | 1,353 | 1.7 |
| 4. Irrigated Plantations | 80 | 0.1 |
| 5. Scrub Forests | 796 | 1.0 |
| 6. Riverain Forests | 239 | 0.3 |
| 7. Wastelands including areas under Ice and Snow | 28,501 | 35.8 |
| 8. Water Bodies (rivers only) | 1,274 | 1.6 |
| 9. Others | 159 | 0.2 |
| **TOTAL:** | **79,610** | **100.0** |

## Pakistan Geography

The geography of Pakistan is a profound blend of landscapes varying from plains to deserts, forests, hills, and plateaus ranging from the coastal areas of the Arabian Sea in the south to the mountains of the Karakoram Range in the north. Pakistan geologically overlaps both with the Indian and the Eurasian tectonic plates where its Sindh and Punjab provinces lie on the north-western corner of the Indian plate while Baluchistan and most of the Khyber-Pakhtunkhwa lie within the Eurasian plate which mainly comprises the Iranian Plateau, some parts of the Middle East and Central Asia. The Northern Areas and Azad Kashmir lie mainly in Central Asia along the edge of the Indian plate and hence are prone to violent earthquakes where the two tectonic plates collide.

### FIGURE 7: TOPOGRAPHY OF PAKISTAN

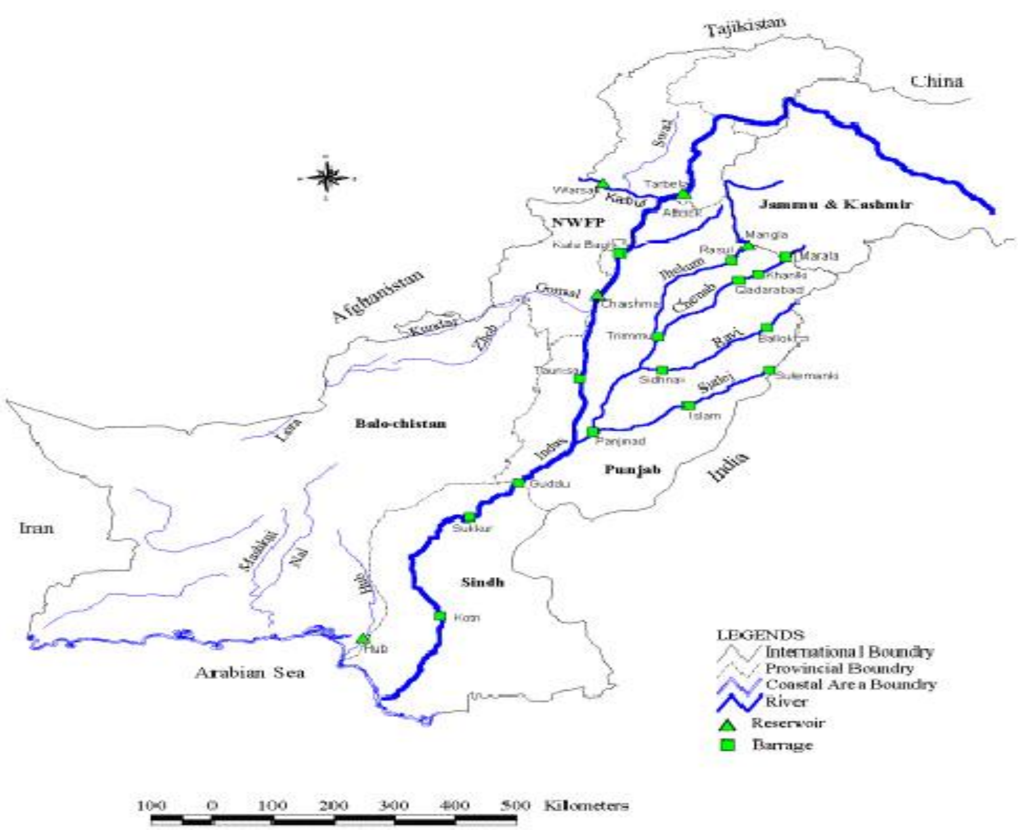


The topographic map above shows the three major geographic areas: northern highlands, Indus River plain, and Balochistan Plateau.  Pakistan is bordered by Afghanistan to the north-west and Iran to the west while the People's Republic of China borders the country in the north and India to the east. The nation is geopolitically placed within some of the most controversial regional boundaries which share disputes and have many-a-times escalated military tensions between the nations, e.g., that of Kashmir with India and the Durand Line with Afghanistan. Its western borders include the Khyber Pass and Bolan Pass that have served as traditional migration routes between Central Eurasia and South Asia.

## Pakistan Hydrology

The Indus River is the 12th largest river system in the world and drains through most of Pakistan. Pakistan is heavily dependent on the river as a major source of water supply. This dependence on a single river system is a cause for concern especially as the Indus River is also a trans-boundary river shared by India. The teeming populations of these countries demand for water continues to rise and the supply from the river is no longer sufficient to meet the demand. Groundwater availability in this region is also on the decline. Over-exploitation of the groundwater in many areas is now causing the quality to decline. Groundwater accounts for over 40% of the irrigation needs of the region.  Water from the Indus River is relied upon to provide potable drinking water to the 130 million people, generate power and fill the gap in irrigation demand. Dams on the main stem of the Indus River and its tributaries produce most (45%) of the electrical energy for Pakistan.

**FIGURE 8:  PAKISTAN RIVERS**[72]

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72 http://www.wildlifeofpakistan.com/IntroductiontoPakistan/riversofPakistan.htm

The Indus River originates from the Karakoram, Hindu Kush, and the Himalayan regions along the north and northeastern borders of Pakistan. The rivers flow south towards the Arabian Sea with a combined annual average volume of 178 bcm (for all major rivers) discharged into the Indus Plains. The Indus River system forms a link between two large natural reservoirs, the snow and glaciers in the mountains and the groundwater contained by the alluvium in the Indus Plains of the Sindh and Punjab Provinces of Pakistan.

The Indus Basin comprises of the Indus River, its five major left bank tributaries the Jhelum, Chenab, Ravi, Beas and Sutlej Rivers, and one major right bank tributary, the Kabul. The Indus Waters Treaty of 1960, brokered by the WB, apportions the flows of four main rivers to Pakistan, the Indus, Kabul, Jhelum, and Chenab Rivers, and the remaining three to India - Ravi, Beas and Sutlej. Because of the socio-economic importance of this river, its study is important to provide information needed for its management, and to ensure that it is sustainable and able to continue support the population and environmental flows.

### Threats to Water Resources

According to the WB, Pakistan, with an average rainfall of under 240 millimeters a year, is one of the world's most arid countries. As rivers and sub-soil waters continue to dry up—due to expanding demand from agriculture and population increases, as well as from climatic changes—water continues to be a resource in limited supply in both Pakistan and India. If not properly dealt with, competition over water could lead to increased conflict between the two countries[73]. A WB report[74] on irrigation pump efficiency finds:

- Pakistan is facing serious threats from escalating water shortages. Over half Punjab’s share of water in agriculture is lost in canals and watercourses.
- A Punjab government project, supported by the World Bank is providing farmers more efficient irrigation systems, community support, and better technology, maximizing water productivity, minimizing losses, and increasing yields.
- “Four hours of water supply was not enough to irrigate even 2 acres of land through the conventional flooding method. However, now 4 to 5 acres of land can be irrigated in less than one hour,” says a beneficiary farmer in District Layyah, Punjab.

ADB’s 2013 report titled Asian Water Development Outlook[75] produced the following key messages:

- Make the best use of already developed water resources by investing in and incentivizing "reduce, reuse, recycle" systems;
- Unlock the performance of water utilities through corporatization;
- Invest in better sanitation to boost health, productivity, and the economy;
- Mobilize rural communities for equitable and just access to water and sanitation;
- Embrace the challenge of the water–food–energy nexus;
- Manage groundwater as a valuable and limited resource;
- Revitalize irrigation institutions for transformation of irrigation services;
- Make integrated water resources management a priority;
- Mobilize additional resources to clean up rivers;

[73] http://www.ecc-platform.org/index.php?option=com_k2&view=item&id=1289:water-shortages-threaten-renewed-conflict-between-pakistan-india&Itemid=750
[74] http://www.worldbank.org/en/news/feature/2014/04/18/improving-punjab-irrigation-more-crops-from-every-drop
[75] http://www.adb.org/publications/asian-water-development-outlook-2013

- Create insurance mechanisms to minimize reliance on disaster relief; and
- New problems demand institutions crafted for current challenges.

According to WWF[76], there are various threats and problems to the water resources and their management in this region. Some of them can be enumerated as follows:

- Demand: According to government estimates, the population of Pakistan is expected to grow by 2.1 % over the next 25 years. The population of the Northern Areas is set to grow even faster, that is, by 2.5% per annum. This means that the water availability for agriculture needs to grow by at least 30% in the next ten years just to maintain the present level of usage per capita. Within the domestic sector increase in demand will be higher, that is, almost 50% over the next decade, because of accelerated urbanization and increased domestic water usage in rural communities (GoP & IUCN, 2003).

Therefore if proper management of water and development of additional water resources is not adequately carried out, there could be a perceptible shortage of this resource with serious implications for the economy of the region.

- Pollution: Increasing pollution is threatening the water supply of the region. This increase is coming from the pressure of population increase. As mentioned before, water in the towns and villages is generally not potable except where well water is used or where interventions have reduced contamination. For example, two of the major water channels that are the source of drinking water to the town of Gilgit have become open sewers from the effluent and other human-generated waste running into it. Here many houses situated along the water channels dump their garbage right into the channels due to lack of proper disposal facilities. In rural areas also, the pollution of water channels is a problem.

Water pollution is also increasing from increased chemical fertilizer use in the region. For example, in the Gilgit district almost 93% of the farmers now use chemical fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support). Clearly, agriculture will benefit from water-saving tools like drip irrigation and drought-tolerant crop varieties.

## Soils of Pakistan

According to UNEP, The soils of Pakistan are derived from two types of parent materials:

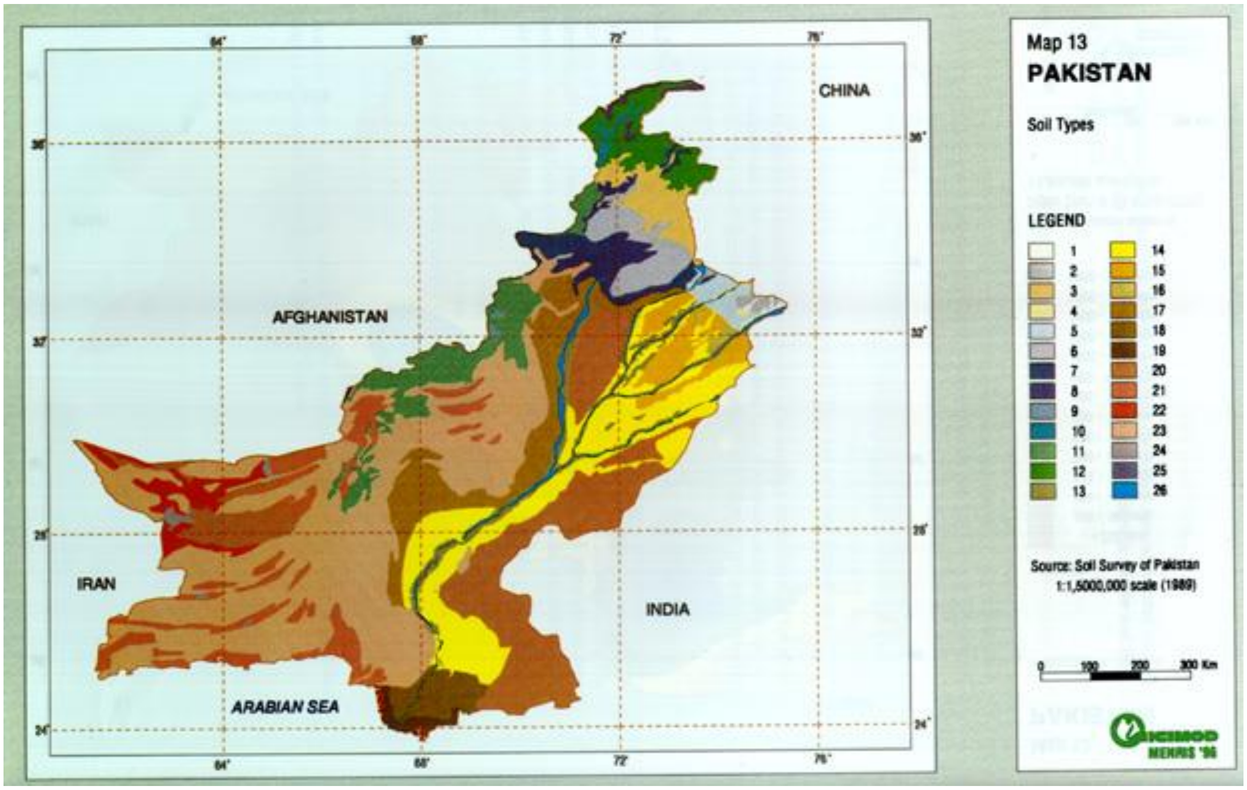
1) Alluvium, Loess and wind reworked sands. They are of mixed mineralogy; and 2) Residual material obtained from weathering of underlying rocks. Most of the rocks are Calcareous. In some areas, Granites have produced non-calcareous soil material. Very small quantities of salts are released from most of the rocks. The soils are therefore, essentially non-saline. The figure below depicts the major soil types of Pakistan, and is matched with Pakistan soil type classifications shown in the following soil type table.

Soil Classification: The soils of Pakistan have acquired distinct characteristics from the parent material and by their mode of formation. The river-laid sediments have developed into Alluvial Soils. The desert sands have turned into distinct soils. The hills, mountains and the plateaus have produced Residual Soils with patches of Alluvial, Loess and other soils. Accordingly, the soils of Pakistan can be classified into the following six types: Alluvial Soils of the Flood Plains; Alluvial Soils of the Bar Uplands; Soils of the Piedmont Plains; Desert Soils; Soils of Potwar Plateau; and Soils of Western Hills.

[76] http://www.wwfpak.org/nap/dnap_freshwater_threats.php

The best loamy-clay soils (yellow, number 14) follow the major river systems while rolling to hilly places are dominated by sandy soils (medium brown, number 20) and mountainous regions are dominated by shallow loamy-gravelly soils (light brown, number 23) comprising the largest percentage by areas.

**FIGURE 9: SOILS OF PAKISTAN (UNEP)**




## TABLE 15: SOILS OF PAKISTAN (UNEP)

| Soil Type | Area (000' ha) | Percentage |
|---|---|---|
| 1. Loamy and sandy stratified soils | 1.0 | 0.1 |
| 2. Loamy and clayey non-calcareous soils | 4.6 | 0.6 |
| 3. MOUNTAINS: Loamy shallow soils<br>VALLEYS : Loamy non-calcareous soils | 18.6 | 2.3 |
| 4. Loamy sandy stratified soils | 1.5 | 0.2 |
| 5. Loamy clayey non-calcareous soils | 7.7 | 1.0 |
| 6. Loamy non-calcareous soils of alluvial/loess plains | 18.2 | 2.3 |
| 7. MOUNTAINS: Loamy and shallow soils<br>VALLEYS : Loamy soils | 10.2 | 1.3 |
| 8. MOUNTAINS: Rock out-crops loamy and shallow soils<br>VALLEYS : Loamy soils | 17.0 | 2.1 |
| 9. Loamy partly gravelly soils | 0.7 | 0.1 |
| 10. MOUNTAINS: Loamy shallow soils and rock out-crop<br>VALLEYS : Loamy soils | 2.7 | 0.3 |

| | | |
|---|---|---|
| 11. MOUNTAINS: Rock out-crop and loamy very shallow soils<br>VALLEYS : Loamy soils | 41.7 | 5.2 |
| 12. MOUNTAINS: Rock outcrop, some loamy very shallow soils<br>VALLEYS : Mainly loamy soils | 22.7 | 2.9 |
| 13. Loamy sandy stratified soils | 18.8 | 2.4 |
| 14. Loamy clayey soils | 90.4 | 11.4 |
| 15. Loamy soils of old river terraces | 21.9 | 2.8 |
| 16. Loamy clayey mainly dense saline sodic soils | 2.0 | 0.3 |
| 17. Loamy and clayey partly saline sodic soils | 52.7 | 6.6 |
| 18. Mainly loamy saline soils | 15.3 | 1.9 |
| 19. Silty and clayey saline soils | 5.6 | 0.7 |
| 20. Rolling to hilly sandy soils | 116.9 | 14.7 |
| 21. Mainly loamy partly gravelly soils | 46.6 | 5.8 |
| 22. Mainly loamy partly gravelly soils | 16.7 | 2.1 |
| 23. MOUNTAINS: Rocky out-crop with patchy soils<br>VALLEYS : Mainly loamy partly gravelly soils | 244.5 | 30.6 |
| 24. Clayey and loamy severely saline sodic soils | 2.7 | 0.3 |
| 25. Glaciers and snow caps | 3.4 | 0.4 |
| 26. Rivers | 13.0 | 1.6 |
| **TOTAL:** | **796.1** | **100.0** |

### Issue: Pesticide Soil Adsorption, Leaching and Water Contamination Potentials

Each pesticide has physical characteristics, such as solubility in water, ability to bind to soil particles and be held (adsorbed) by soil so they do not enter the soil water layers and the ground water table, and their natural breakdown rate in nature. This data can be found for the pesticides discovered in Pakistan by checking each pesticide on the following website: http://sitem.herts.ac.uk/aeru/footprint/en/index.htm. The water solubility, soil adsorption and natural breakdown rates, if available, are included throughout the webpage, for each parent chemical.

In general, pesticides with water solubility greater than 3 mg/liter have the *potential* to contaminate groundwater; and pesticides with a soil adsorption coefficient of less than 1,900 have the *potential* to contaminate groundwater. In addition, pesticides with an aerobic soil half-life greater than 690 days or an anaerobic soil half-life greater than 9 days have the *potential* to contaminate groundwater. Moreover, pesticides with a hydrolysis half-life greater than 14 days have *potential* to contaminate groundwater.

The potential for pesticides to enter groundwater resources depends, as indicated above, on the electrical charge contained on a pesticide molecule and its ability and propensity to adhere to soil particles, but this also depends on the nature and charge of the soil particles dominant in the agriculture production area. Sand, clay and organic matter, and different combinations of all of these, have different charges and adhesion potential for organic and inorganic molecules. Sandy soil often has less charge capacity than clay or organic matter, and will thus not interact significantly with and hold charged pesticide molecules. So, in areas with sandy soil, the leaching potential for pesticides is increased.

A pesticide's ability to enter groundwater resources also depends on how quickly and by what means it is broken down and the distance (and thus time) it has to travel to the groundwater. If the groundwater table is high, the risk that the pesticide will enter it before being broken down is increased. Thus, a sandy soil with a high water table is the most risky situation for groundwater contamination by pesticides. Groundwater contamination potential for each pesticide active ingredient available in Pakistan is provided in Annex 7.

In areas with highly sandy soils, such as those noted above, pesticides that are known water pollutants, colored in red in Annex 7, as well as pesticides that are "potential" water pollutants, as noted in column 9, must be replaced by pesticides (especially herbicides) that are not potential pollutants.

#### Recommendations for Mitigation

- Ensure that pesticides labeled for certain types of use environments, or areas, are in fact used according to label recommendations.
- Since transport of pesticides absorbed to soil particles is a likely transportation route to waterways, techniques must be employed to reduce farm soil erosion (such as terracing, employing ground covers between rows, planting rows perpendicular to the slope, using drip irrigation, and so on).
- Do not use herbicides or other pesticides with high leaching and groundwater pollution potential (see Annex 7, column 9) on highly sandy soils or soils with water tables close (2-3 meters) to the surface. Pay particular care when spraying near waterways, so that pesticides do not enter surface water.
- Do not spray synthetic pyrethroid or other pesticides with high toxicities to aquatic organisms before an impending rainstorm, as they can be washed into waterways before breaking down.

## 3.9 Factor I: Availability of Other Pesticides or Non-Chemical Control Methods

This section identifies less toxic synthetic (produced in laboratories or factories), as well as non-synthetic or 'natural' (extracts of naturally-occurring plants, spices, oils, fatty acids, induced resistance elicitors, minerals, microbes or microbial extracts) pesticide options for control of pests, and their relative advantages and disadvantages. Many of these 'natural' pesticides can be toxic to humans as well, and several are even in products classified as RUPs due to environmental risks; thus safe pesticide use practices extend to these natural as well as synthetic pesticides.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that none of the projects knew of alternate chemical (artisanal and commercial) and non-chemical tools available.*

#### Agriculture Seed Treatment, Field Crops, Greenhouse/Nursery crops and Food Security/Warehouses, Construction

Annex 1—the heart of this PERSUAP—contains numerous non-chemical preventive methods for every major pest or disease of every major crop and stored grain crop of Pakistan. It is the intent of this PERSUAP that USAID projects dealing with agriculture and food security use this valuable resource, which compiles all known IPM tools and tactics for each pest.

#### Veterinary

Annex 1 contains several alternative livestock IPM tools including pesticides. Further, there are several alternate livestock IVM tools and techniques listed above under factor C.

#### Avian Influenza/Disinfectants

The primary alternatives to disinfectants to control bird flu are containment and quarantine of both infected and uninfected birds, as well as practices found in website noted above under Factor C[77]. The non-chemical alternative to chemical water disinfection is to use radiation, like UV rays.

#### Health/Malaria/Dengue

There are several alternate mosquito IVM tools and techniques listed above under factor C.

### Issue: Natural pest controls availability

Natural chemicals: Many non-synthetic chemical IPM tools and technologies are listed in Annexes 4 and 5. The list of natural pesticides likely entering Pakistan is not as extensive as other developing countries. In general, most synthetic nematicides and soil pesticides/fumigants are very highly toxic. However, there are some companies producing next-generation natural chemicals in the USA: Bio Huma Netics, http://www.bhn.name for natural nematicides and Agra Quest, http://www.agraquest.com for bioactive essential oils.

For commercial operations, especially greenhouses and nurseries, biological controls and beneficial organisms are available commercially from local Biolabs as well as two large international companies, Koppert of Holland and Biobest of Belgium. Koppert provides many biological controls against spider mites, beetles, leaf miners, mealy bugs, thrips, aphids, whiteflies, and moth and butterfly larvae. Koppert also provides the Koppert Side Effects List, a list of the side effects of pesticides on biological organisms, at http://www.koppert.com. Biobest of Belgium provides many of the same or similar biological controls as Koppert, and includes a control against leafhoppers. Their website is: http://www.biobest.be. These are especially useful for greenhouse and nursery seedling production systems. Both companies also sell live bumblebees for greenhouse pollination assistance.

#### Recommendations for Mitigation

- As appropriate, USAID projects integrate low-risk natural chemical pest controls that are found available in Pakistan.

## 3.10 Factor J: Host Country's Ability to Regulate or Control the Distribution, Storage, Use, and Disposal of the Requested Pesticide

This section examines the host country's existing infrastructure and human resources for managing the procurement and use of the proposed pesticides. If the host country's ability to regulate pesticides is inadequate, the proposed action – procurement and use of pesticides – could result in greater risk to human health and the environment.

[77] http://www.oie.int/animal-health-in-the-world/web-portal-on-avian-influenza/

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that most of the projects had confidence in Government of Pakistan's abilities to regulate pesticides, although two did note that it is difficult for Pakistan to implement enforcement of regulations due to lack of sufficient resources.*

Since 2013, there is no change in the rules and regulation with regard to pesticides in Pakistan. However, there has been a change in responsibilities. Previously the Department of Plant Protection was dealing with pesticides in Pakistan. After the recent dismemberment of Ministry of Food and Agriculture, a new ministry by the name of National Food Security and Research was established and the Department of Plant Protection has been placed under this new establishment without changing any rule or regulation (http://www.plantprotection.gov.pk/download.htm). During the interim period the Plant Protection Department was attached with Ministry of Commerce.

#### Agriculture Seed Treatment, Field Crops, Greenhouse/Nursery crops, Food Security/Warehouses and Veterinary

The Ministry of Agriculture in Pakistan has produced updated pesticide regulations and an up-to-date list of permitted pesticides for agriculture, veterinary and warehouse pest control. Pakistan has reasonable research, extension and enforcement services, except in areas like FATA. Border crossings are less controlled than optimal, leading to the entry of generic Chinese products of variable quality.

#### Avian Influenza/Disinfectants and Health/Malaria/Dengue

The parts of the government that deal with Avian Influenza, malaria and dengue control have international guidelines that they use for controlling the distribution, storage, use and disposal of pesticides specific for each sector.

### Issue: Limited resources to control pesticides

Pakistan has limited systems and resources enforcing the registration and regulation of the import, sale and use of pesticides. Further, their ability to cover the country and eliminate banned or highly toxic chemicals is limited due to limited resources. The list of pesticides available contain some very highly toxic chemicals that must not be handled by illiterate, untrained, unprotected and often unaware small-holder farmers like those found throughout Pakistan. Most farmers do not have access to and cannot afford PPE in order to follow GAPs.

### Issue: Illegal Products from Neighboring Countries

"Leaky" country border crossings could be likely sources of pesticides that are not officially registered in Pakistan. Some PIC chemicals have been found in formal and informal markets in the region, as have some POPs chemicals.

### Issue: Disposal of Pesticide Containers

Some Pakistani farmers retain empty and partially full plastic pesticide containers. Some use them to store water. Before disposal, the standard practice has been to triple-rinse the containers, puncture them to discourage re-use, and bury or burn them. Burning plastic bottles and single-use pesticide sachets can lead to the formation of toxic (and POPs) furans and dioxins, and is not recommended. GlobalGAP and other S&C systems require that empty pesticide containers are triple rinsed over a pesticide soak pit with layered soil, lime and carbon, or a bioactive pit, and then properly stored in plastic drums in the field or storage shed, to await disposal or recycling. There are no pesticide containers recycling activities occurring anywhere in Asia. The website http://www.epa.gov/oppfead1/labeling/lrm/chap-13.htm provides pesticide disposal options.

#### Recommendations for Mitigation

- Pakistan assistance projects staff members encourage and follow developments in the regulation and registration of pesticides in Pakistan.
- Absolutely no POPs or PIC chemicals must be used on Pakistan assistance projects -supported fruit and vegetable production. This includes endosulfan, a POPs Treaty candidate, which is highly popular among vegetable producers the world over, but has killed numerous farmers as well.
- Pakistan assistance projects field staff members encourage and support the use of GlobalGAP best practices with pesticide storage, use and disposal, whether or not certification is required for market access.

## 3.11 Factor K: Provision for Training of Users and Applicators

USAID recognizes that, in addition to the use of PPE, safety training is an essential component in programs involving the use of pesticides. The need for thorough training is particularly acute in developing countries, where the level of education of applicators may typically be lower than in developed countries.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that most of the agriculture projects had performed or were planning to perform IPM and safety training, while construction, health and water/sanitation projects did not provide IPM or pesticide safety training.*

Agriculture Seed Treatment, Field Crops, Greenhouse/Nursery crops, Food Security/Warehouses and Veterinary

### Issue: Farmers need intensive and repeated training

Training in Safe Pesticide Use and GAP/IPM are of paramount importance for Pakistan assistance projects farmers, farm laborers and other sector personnel using pesticides. Pakistan assistance projects -supported agriculture activities must focus strongly on providing GlobalGAP, as well as IPM and safe pesticide use training. Additional and refresher training are superb means for affecting beneficiary farmer behavior, now, as they continue to expand their agricultural opportunities, and before risky behaviors become further set. Annex 9 provides a list of training topics appropriate for the agriculture sector, and a phased approach for doing the training, beginning with training project staff and local sector leaders (lead farmers for instance) in recommended topics and then using those trained people to train additional project beneficiaries.

#### Avian Influenza/Disinfectants and Health/Malaria Dengue

Most government and donor workers who do Avian Influenza, or malaria and dengue control receive proper training and PPE from WHO and donors.

#### Recommendations for Mitigation

- Implement GAP, IPM and Pesticide Safe Use training for Pakistan USAID assistance projects staff and beneficiaries.
- Use Annex 1 to produce and promote the use of Pest Management Plans for farmers to anticipate and better manage primary pests.

## 3.12 Factor L: Provision Made for Monitoring the Use and Effectiveness of Each Pesticide

Evaluating the risks, impacts and benefits of pesticide use must be an ongoing, dynamic process. Pest resistance is one of the risks for which this element is intended, as well as human health and safety and environmental effects.

*The 2014 questionnaire sent to USAID-supported projects (Annex 18) found that most of the projects had produced a quality EMMP that would be used to track implementation of risk reduction measures.*

### Agriculture Seed Treatment, Field Crops, Greenhouse/Nursery crops, Food Security/Warehouses and Veterinary

Record keeping must track quantities and types of pesticides used. Making notes on effectiveness of individual pesticides and pest numbers will help develop a more sustainable pesticide use plan for each Productive Agriculture Project beneficiary producer. Records of farmers, as well as Pakistan assistance projects agronomists, will need to make note of any reductions in pesticide efficacy experienced, which is the first indication that resistance may be developing, and then a strategy needs to be in place to determine a shift to a different pesticide class, and rotation among classes, to overcome resistance development.

### Avian Influenza/Disinfectants and Health/Malaria/Dengue

Most government and donor workers who do Avian Influenza, and dengue or malaria control receive proper training on record keeping from WHO and donors. And, these are more like emergency programs responding to an immediate short-term need. Extensive records are available on both sectors.

### Issue: Pakistan assistance projects and Farm Record-Keeping

On Pakistan assistance projects proposed demonstration farms, pesticide use documentation is either non-existent or not retained from year to year. Developing a more systemized approach to record keeping will allow seasonal and annual comparison of pesticide effectiveness, pest numbers, crop production, maintenance of safety equipment, and so on. The following aspects should be included in the record keeping system, for a USAID-funded program:

- Local, EPA and EU regulatory compliance: A list of country, EPA and EU laws related to the use of agrochemicals for plant protection, short notes on the relevance of the law, dates the laws come into or exit force and MRLs for each crop-pesticide combination.
- A pesticide checklist: This list allows agronomists to ensure that the pesticides they are using are not banned by international treaties (POPs, PIC) and registered through the USEPA. It must also provide notes on special safety requirements.
- GAPs/IPM measures tried/used (see Annex 1): Pakistan assistance projects agronomists should try to incorporate a minimum of at least three new IPM measures per annum and document their success or failure.
- PPE: Lists of the types of equipment made available to applicators, number of pieces, prices and contact details of suppliers, dates when equipment needs to be washed, maintained or replaced. PPE must be numbered or personally assigned to applicators to ensure that it is not taken home where (as a contaminated material) it could pose a risk to family members.
- Monitoring/recording pests: Agronomists must incorporate into their records regular field pest monitoring and identification. This could be done by the agronomists themselves, or if properly trained, by farmers.

- Environmental conditions: Field conditions must be incorporated into the record keeping system (for example; precipitation, soil analyses and moisture, soil pH, temperatures and so on).
- Information must be transmitted at least annually and Pakistan assistance projects must report to USAID on this progress in pesticide safety and GAP/IPM use in annual reports.

### Issue: Monitoring by Pakistan assistance projects Field Staff and Farmers Should Detect

- Resistance: Pesticide resistance development among pests has likely occurred and could eventually occur more, and will be noted by farmers complaining that the spray no longer works as it once did.
- Human poisonings and any incidences of chronic health issues.
- Farm animal and livestock deaths.
- Any incidences of water pollution.
- Fish, bird, wildlife or honeybee kills.

Any of the above items must be reported immediately to USAID. Other information must be transmitted at least annually to USAID, and Pakistan assistance projects must report on this progress in pesticide environmental and human health safety in annual reports.

### Issue: Pakistan assistance projects Planning and Reporting

Several issues could receive more attention in Pakistan assistance projects annual work plans and annual reports. These include a section on Environmental Impact Mitigation and Best Practices, with subsections (and issues) on:

- Country and EPA regulation compliance (documents and enforcement status, risk, pollution, mitigation)
- GAPs/IPM measures tried/used and on what percent of Pakistan assistance projects farms
- Biodiversity and conservation (soil, water, energy, protected habitats, biodiversity and protected species) measures used on what percent of farms
- Inputs and PPE use and issues (types, amounts and issues with products, sprayers, MRLs, REIs, MSDSs)
- Training/capacity building in IPM and Safe Use (hands-on, demos, sessions, meetings, extension, flyers, brochures, pamphlets, posters, crop technical GAP information sheets, and radio and TV outreach/safety message enforcement)

#### Recommendations for Mitigation

- Pakistan assistance projects to follow all of the above best practices in monitoring, record keeping, evaluation/analyses and reporting.
- Site managers/agronomists must develop a record-keeping system, which is also a requirement for GlobalGAP and other international market-driven produce certification systems. It is highly recommended that records be kept in an electronic format for easy editing, updating and modification.
- Using Annex 11, Pakistan assistance projects staff must put plans for monitoring the environmental and human health impact of production activities, following recommendations found in this PERSUAP into the Annual Action Plans.

- Pakistan assistance projects staff keeps records on the implementation of the recommendations found in this PERSUAP, and report on them in Quarterly and Annual Reports, under a heading titled “Environmental Impact Mitigation and Best Practices”.

# SECTION 4: 2014 PESTICIDE SAFE USE ACTION PLAN (SUAP) FOR PAKISTAN USAID ASSISTANCE PROJECTS

**Action Plan Title: Actions to increase awareness of and mitigate pesticide risks on Pakistan assistance projects sites**

Action Plan Objectives: Reduce risks from pesticides.

*On the following Action Plan Matrix,* ***COP or delegate should insert the start and end dates for each activity (see recommendations in Executive Summary for guidance on deadlines) or action or groups of sub-actions or activities to complete the action with the names of those responsible for each action, and a budget.*** *Once this is action plan is completely filled, and actions are under way or done, it can be transmitted to AID to show Regulation 216 compliance progress reducing pesticide risks on your project.*

### TABLE 16: ACTION PLAN MATRIX

| Actions/Activities | Start | End | Who | Budget |
|---|---|---|---|---|
| **Reiterating Pesticide Restrictions** | | | | |
| Ensure that USAID beneficiaries do not procure and use locally-available insecticides containing banned POPs or PIC chemicals, including endosulfan, or Montreal Protocol chemical methyl bromide | | | | |
| Ensure that USAID beneficiaries do not procure and use fumigant aluminum phosphide to treat stored grain or produce (instead procure and use trained and equipped fumigation services) | | | | |
| USAID projects assign local pesticide commercial product names to Active Ingredients in PERSUAP Annex 7 | | | | |
| Ensure that USAID beneficiaries do not procure and use pesticide products containing active ingredients shaded red in Annex 7 | | | | |
| USAID project staff members check for any movement by the Pakistan MINFAL on registration of pesticides, and obtain information on new pesticide registrations | | | | |
| | | | | |
| | | | | |
| **Pesticide Risk Awareness and Mitigation** | | | | |
| USAID projects provide annual training for project staff and beneficiaries using the training topic list in Annex 9 | | | | |
| Ensure that USAID beneficiaries and farmer associations or cooperatives each have 1 or 2 sets of PPE for the group to share; assign responsible PPE caretakers | | | | |
| Ensure that USAID beneficiaries use PPE and apply pesticides only early in the early morning or late | | | | |

| | | | | |
|---|---|---|---|---|
| afternoon when it is cooler, and when there is no wind or rain | | | | |
| USAID projects annually test and certify pesticide users on knowledge of human safety and environmental protection | | | | |
| **Good Agriculture Practices/IPM** | | | | |
| USAID projects test pest-specific crop-pest-IPM-pesticide information in Annex 1 with beneficiary farmers and food warehouse managers for field use, validation, modification or adaptation | | | | |
| USAID projects use information in Annex 1 to produce crop-specific PPMPs, and then field reference guides or posters for farmers to use to anticipate and manage pests | | | | |
| USAID projects promote the use of artisanal and commercially-available natural chemicals listed in Annexes 1, 4 and 5, as available | | | | |
| USAID projects follow GlobalGAP standards at http://www.epa.gov/oppfead1/labeling/lrm/chap-13.htm for empty container disposal and pesticide record-keeping | | | | |
| | | | | |
| | | | | |
| | | | | |
| **Project Management Responsibilities** | | | | |
| USAID projects define and assure safe use practices | | | | |
| USAID projects define appropriate methods of pesticide handling, storage, transport, use and disposal | | | | |
| USAID projects keep copies of the current list of pesticide AIs analyzed by this PERSUAP at all project sites | | | | |
| USAID projects collect and keep copies of MSDSs for each commercial pesticide that beneficiaries use at all project sites | | | | |
| USAID projects keep copies of prohibited pesticide products containing active ingredients shaded red in Annex 7 at all project sites | | | | |
| USAID projects keep PERSUAP recommendation implementation records and report on them in Annual Reports, under a heading titled "Environmental Compliance and Best Practices" | | | | |
| USAID projects provide for SUAP enforcement | | | | |

**Action Plan Goals: Decrease the number of farmers or other sector beneficiaries unaware of pesticide safety, environmental and natural resource protection, and IPM concepts.**

**Action Plan Discussion:**

**Action Plan Final Sign-off: COP ___________________________, date: _______________**

Once filled and signed by COP, this Action Plan can be sent to USAID for project management monitoring purposes, so USAID staff can see the degree to which PERSUAP recommendations are being implemented, issue with implementation, and to set future targets for impacts of pesticide safety activities.

# ANNEXES

## Annex I: Matrix of Pakistan Sectors & Crops with Primary Pests, Pest Prevention Tools and Tactics, and Pest Control Tools

### TABLE 17: MATRIX OF PAKISTAN SECTORS AND CROPS WITH PRIMARY PESTS, PEST PREVENTION TOOL AND TACTICS, AND PEST CONTROL TOOLS

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| | **Cereals/Small Grains: Rice** | |
| Rice stem borers: Yellow (*Scirpophaga incertulas*); White (*Scirpophaga innotata*); Pink (*Sesamia inferens*) | • Use resistant and early-maturing varieties. Improved semi-dwarf varieties are generally more resistant to stem borers than the tall traditional ones.<br>• Transplant & grow healthy rice seedlings and plants.<br>• Harvest at the very base of the plants, or plow stubble under and flood.<br>• Early/synchronized planting & water management | • Use natural extracts of neem/azadirachtin and chili peppers.<br>• Use synthetic insecticides containing Lambda – Cyhalothrin (less than 10%), Fenitrothion, Imidacloprid (recommended for use during vegetative growth, not flowering), Spinetoram. |
| Rice Grasshoppers, *Hieroglyphus banian* | • Hand pick early in the morning when hoppers are less active.<br>• Natural control of variegated grasshoppers may occur by the fungus *Entomopthora grylli* in high humidity. | • There are very few additional controls for Orthopteran pests like these.<br>• Use myco-insecticide to control grasshoppers at breeding sites. |
| Rice leaf folder (*Cnaphalocrocis medinalis*) | • Use improved hybrid seed.<br>• Plant at correct time in correct spacing.<br>• Natural control by predators and parasitoids is usually effective.<br>• Release of *Trichogramma japonicum* parasitoids. | • Use of applications of natural artisanal or purchased neem/azadirachtin.<br>• Insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), spinetoram or formulations ethofenprox or synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), bifenthrin and lambda cyhalothrin (use formulations 10% and below). |

| **Sector & Primary Pests** | **Preventive management IPM tools/tactics to integrate** | **Curative management IPM tools/tactics** |
|---|---|---|
| Leaf hoppers<br>White backed plant hopper (*Sogatella furcifera*)<br>Green rice leaf hoppers (*Nephotettix spp*)<br>Brown plant hopper (*Nilaparvata lugens*) | • Grassy weeds should be eliminated from the farm and surrounding areas and staggered planting should be avoided.<br>• Predation by spiders can provide significant reduction of leafhopper populations. | • Use of insecticides containing Buprofezin, Pymetrozine, Malathion, Ethofenprox, Azadirachtrin, or Imidacloprid (recommended for use during vegetative growth, not flowering). |
| Root or foot rot (*Fusarium moniliforme*) | • Use of resistant cultivars.<br>• Use clean (non-infested) seed.<br>• Burn stubbles after harvest. | • Treat seed with dilute sodium hypochlorite (Clorox). |
| Bacterial leaf blight<br>*Xanthomonas campestris* | • Use of resistant and disease-free cultivars.<br>• Disinfection of the cutting tools used to make propagation materials.<br>• Use of crop rotation. | • For control, use copper hydroxide (use only Class II and III products, not Class I). |
| Rice blast (*Pyricularia oryzae*) | • Use of resistant cultivars.<br>• Destruction of infested residue.<br>• Use of non-infested seed.<br>• Water seeding (not drill seeding).<br>• Continuous flooding.<br>• Avoid using excess nitrogen.<br>• Do not plant too early or too late.<br>• Avoid close planting in nurseries. | • Use application of synthetic fungicides containing metalaxyl or azoxystrobin. |
| Stem rot<br>*Sclerotium oryzae* | • Use the most resistant varieties available to reduce carry-over inoculum.<br>• Do not exceed maximum planting density.<br>• Winter irrigation and soil-applied phosphorous fertilization suppress stem rot.<br>• Sanitation: Cut and remove or burn rice residues after harvest.<br>• Moldboard plowing buries inoculum sclerotia and keeps them away from stems.<br>• Let a field go fallow for one year or more, crop rotation.<br>• Avoid using excess nitrogen. | • Use application of synthetic fungicides containing metalaxyl or azoxystrobin. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| | **Cereals/Small Grains: Maize/Corn** | |
| Jassids/Leafhoppers (*Zygina spp., Dalbulus maidis*) transmits Corn Stunt Disease | • Practice early planting.<br>• Maintain a corn-free period (remove and destroy volunteer corn plants from other crop fields) over winter months.<br>• In sweet (green) corn, use reflective mulches. | • Use seed treatment with systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiacloprid (recommended for use during vegetative growth, not flowering).<br>• Use synthetic pesticides containing spinetoram and synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |
| Sugarcane Pyrilla Leafhopper, *Pyrilla perpusilla* | • Practice early planting.<br>• Maintain a corn-free period (remove and destroy volunteer corn plants from other crop fields) over winter months.<br>• In sweet (green) corn, use reflective mulches. | • Use seed treatment with systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiacloprid (recommended for use during vegetative growth, not flowering). |
| Aphids: corn leaf aphid (*Rhopalosiphum maidis, Myzus persicae*) | • Natural enemies include Braconid parasitoids, ground beetles, spiders, rove beetles, ladybird beetles, lacewings, damsel bugs, aphid midges and hoverfly larvae.<br>• To monitor aphid populations, examine the undersides of the leaves and the bud areas for groups or colonies of aphids. Grow different crops or grow crops in rotation every cropping season. This practice provides food, shelter, and it increases the number of natural enemies that prey on aphids. At the same time, it disrupts the aphids' lifecycle and maintains its population below the economic threshold level.<br>• Plant trap crops such as lupine, nasturtiums, and timothy grass near the crop to be protected (plow under or spray). Anise, chives, garlic, onions, and radish are good companion crops.<br>• Control ants that protect aphids. | • Prompt control is necessary as aphids can multiply rapidly.<br>• Use botanical and homemade water extracts of chili, ginger, neem, turmeric, and soap.<br>• Use synthetic pesticides containing spinetoram, pirimicarb, and synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| | • Avoid using heavy doses of highly soluble nitrogen fertilizers. Instead apply fertilizer into 3 phases: during seeding, vegetative, and reproductive stages of plant growth (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Use yellow sticky board traps placed in field (spread used motor oil on yellow painted plastic, thick cardboard or wood). | |
| Sorghum midge (*Contarinia sorghicola*) | • Use resistant cultivars or varieties.<br>• Use deep autumn plowing.<br>• Regular crop rotation can reduce the midge population. | • Can use synthetic insecticides containing deltamethrin. |
| Spider mites (*Tetranichus species*) | • Crop monitoring<br>• Plant away the other mite host plants.<br>• Destroy weeds and host crops as soon as possible, including the head rows.<br>• Always monitor before treatment with miticides. | • Can use natural miticides containing soap, oil, neem or spinosad (applied with good coverage to leaf undersides).<br>• Can use synthetic miticides containing abamectin (use formulations below 1.9%). |
| Corn earworm (*Helicoverpa = Heliothis armigera, Chloridea obsoleta*) | • Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma.* General predators include lacewings, minute pirate bugs, and damsel bugs eat corn earworm eggs and small larvae.<br>• Monitor fields regularly.<br>• Sanitation: Do crop residue destruction. | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and the Entrust formulation of spinosad, spinetoram.<br>• Use synthetic pesticides containing spinetoram and synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |
| Armyworms (*Mythimna separate, Spodoptera* species) | • Natural enemies include parasitoid Braconid and Cotesia wasps and Tachinid flies as well as damsel bugs, ground beetles, lacewings and weaver ants.<br>• Practice proper field sanitation. Destroy weeds from bordering fields and on field borders. Remove weeds regularly to reduce breeding sites and shelter for armyworm. Remove all plant debris after harvesting. | • Botanical and homemade water extracts include basil, chili, garlic, neem and lemongrass.<br>• Sprays of natural pesticides *Bacillus thuringiensis aizawai* and spinosad.<br>• Use synthetic pesticides containing spinetoram. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| | • Plow and harrow field thoroughly. Sometimes, the small grains or grasses are plowed-under after the eggs are laid on them. As the field is planted and the plants begin to grow, the larvae will continue to develop and will start attacking the plants.<br>• Early warning mechanism e.g. use of pheromone traps to detect adult flight patterns can pre-empt major damage<br>• During outbreaks it is absolutely necessary to use pesticides to control invading caterpillars | |
| Corn stalk borers (*Chilo partellus*) | • Natural enemies of larvae include parasitoids Braconid family of parasitic wasps, wasps of the genus Cotesia, and Tachinid fly larvae. *Trichogramma* parasitoids attack eggs of stalk borers. Predators include ground beetles, lacewing larvae and adults, praying mantis and weaver ants.<br>• Use borer-resistant varieties.<br>• Use crop rotation and intercrop maize with a legume.<br>• Plant early at the beginning of rains or within 2 weeks.<br>• Monitor plants for larva's presence 2-4 weeks after sowing. Select 100 plants randomly across the field. If more than five plants are infested with stalk borer larvae (out of 100 monitored plants), then control measure is necessary.<br>• Intercropping with pulses (cowpea, groundnut) in alternate rows reduces stem borers.<br>• Sanitation: Remove and destroy stalks by burning, feeding to cattle or composting. Plow deeply and harrow. | • Between the egg stage and leaf-feeding stage (before they bore into the stem), use natural pesticides containing BT toxin, neem or spinosad, or deltamethrin. |
| Shoot fly (*Atherigona orientalis*) | • Use resistant varieties.<br>• Plant early to escape the pest.<br>• Replant losses. | • Use seed treated with a systemic insecticide containing imidacloprid (recommended for use during vegetative growth, not flowering), thiamethoxam (recommended for use during vegetative growth, not flowering), or spray with deltamethrin. |
| Cutworms<br>*Ochropleura spp* | • Caterpillar natural enemies (keep populations down) include predators like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae. Parasitic wasps of *Trichogramma* species, *Copidosoma* species, *Apanteles* | • Use of artisanal extracts of garlic or chili pepper or botanical insecticides like neem.<br>• Use of organic biopesticides or microbial |

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| | species, *Diadegma*, and *Hyposoter* species sting and parasitize eggs and larvae (some of these organisms are available commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | controls consisting of *Bacillus thuringiensis*/BT, spinosad.<br>• Use of synthetic pesticides containing indoxacarb, spinetoram, or chlorantraniliprole. |
| Seed rots and seedling blights<br>*Fusarium spp.*<br>*Penicillium spp.*<br>*Diplodia spp.*<br>*Helminthosporium spp.* | • Use high quality seed and good cultural practices.<br>• Do not plant in low areas and do manage soil moisture properly. | • Can use seed treatments with fungicides.<br>• Can use synthetic fungicides containing metalaxyl or thiram. |
| Root and stalk rots<br>*Cephalosporium acremonium;*<br>*Fusarium spp;*<br>*Macrophomina phaseolina* | • Use resistant hybrids.<br>• Eliminate low areas in the field and improve drainage to prevent development of stalk rot.<br>• Good water management to avoid stressing plants, particularly as the crop approaches the flowering stage.<br>• Crop rotation to nonhost crops, such as small grains, can also help reduce the disease potential.<br>• Practice balanced fertility (do not over-fertilize, especially with nitrogen).<br>• Practice sanitation: plowing crop residues under at the end of the season.<br>• Generally, fungicides are not economical for use against stalk rots. | • For seed treatment, use synthetic pesticides containing carboxin + thiram.<br>• For plant disease, use synthetic pesticides containing triadimefon. |
| Leaf spots and leaf blights, *Helminthosporium spp* | • Use resistant or tolerant varieties or hybrids.<br>• Test and maintain soil and plant health.<br>• Rotate maize with other crops.<br>• Sanitation: remove and destroy crop residues. | • Foliar fungicides are generally not economical; if desired, spray with synthetic insecticides containing mancozeb. |
| Smuts:<br>Maize smut (*Ustilago maydis*<br>Head smut (*Sphacelotheca reiliana*) | • Use resistant or tolerant varieties or hybrids, maintain soil and plant health (test these with lab tests).<br>• Rotate maize with other crops.<br>• Destroy smutted plant parts by removal and burning.<br>• Avoid planting in humid conditions. | • For seed treatment, use synthetic pesticides containing carboxin + thiram.<br>• For plant disease, use synthetic pesticides containing triadimefon. |
| Stalk rots: Corn | • Use resistant hybrids. | • For seed treatment, use synthetic |

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| Charcoal Rot (*Macrophomina phaseolini*); Fusarium stalk rot (*Fusarium verticillioides*); Pythium stalk rot (*Pythium aphanidermatum* and other *Pythium* species) | • Eliminate low areas in the field and improve drainage to prevent development of stalk rot.<br>• Good water management to avoid stressing plants, particularly as the crop approaches the flowering stage.<br>• Crop rotation to nonhost crops, such as small grains, can also help reduce the disease potential.<br>• Practice balanced fertility (do not over-fertilize, especially with nitrogen).<br>• Practice sanitation: plowing crop residues under at the end of the season.<br>• Generally, fungicides are not economical for use against stalk rots. | pesticides containing carboxin + thiram.<br>• For plant disease, use synthetic pesticides containing triadimefon. |
| Ear and kernel rots<br>*Aspergillus spp.*<br>*Diplodia maydis*<br>*Gibberella spp*<br>*Fusarium moniliforme*<br>*Helminthosporium spp.*<br>*Nigrospora spp.* | • Use resistant hybrids and disease-free seed.<br>• Do early plantings and crop rotation.<br>• Reduce insect feeding damage by controlling ear- and seed-feeding species (see above for insect control).<br>• Maintain adequate nitrogen, phosphorus, and potassium fertility.<br>• Sanitation: Remove and destroy crop residues and fallen ears. | • Fungicides are not generally recommended. |
| Maize Cyst Nematode (*Heterodera zeae*) | • Use of resistant cultivars<br>• Grow healthy plants (use appropriate seed, spacing, watering, weeding and fertilizer).<br>• Use crop rotation, deep plowing, fallowing and avoid mono cropping.<br>• Rotate with broccoli, cauliflower, sorghum, flax, Sudan grass, rape, and mustard seed which are resistant to nematodes.<br>• Sanitation: Remove and compost crop debris.<br>• Use of organic fertilizer particularly chicken manure and composts to add organic matter and soil structure to sandy soils.<br>• African and French Marigold (*Tagetes minuta* and *T. patula,* respectively) attract and can be used to trap nematodes. But, 2 months after planting, Marigolds must be dug up with roots, and destroyed, or they will serve as a source of inoculation. | • Botanical and homemade water extracts of basil, garlic and neem seed may be effective controls.<br>• Two new commercialized products, once registered for use, can be used as effective nematode controls: the microbe *Myrothecium verrucaria* and natural soil biopesticide labeled as Promax (containing extracts of tomatillo oil and thyme oil). |
| Weeds: | • Proper seed selection. When possible use high quality seeds and certain crop varieties. | • Before planting, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not |

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| | • Perform thorough land preparation (soil tillage, fertilizer, and water management).<br>• Narrow row spacing makes the crop more competitive than the weeds, use intercropping.<br>• Place the fertilizer in such a way that the crop has access to it but the weeds do not. This allows the crop to be more competitive with weeds.<br>• Maintain cleanliness on the irrigation canals.<br>• Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitats for natural enemies.<br>• Regularly clean farm tools.<br>• Use green manure which chokes out weeds.<br>• Use intercropping.<br>• Hand weeding and composting (do not compost weeds that have flowered and set<br>• Hoeing, mowing, and cutting. | Class I).<br>• At planting, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I), pendimethalin.<br>• After planting, use synthetic herbicides containing nicosulfuron, pendimethalin, glyphosate (use only acute toxicity Classes II and III products; not Class I), metribuzin, carfentrazone. |
| **Cereals/Small Grains: Wheat/Winter Wheat, Barley/Winter Barley; Sorghum; Millet** | | |
| Aphids (*Macrosiphum spp, Rhopalosiphum spp)* some transmit BYDV (Barley Yellow Dwarf Virus) | • A number of coccinellid and syrphid predators, parasites and fungal diseases usually keep aphid populations below damaging levels.<br>• Maintain adequate soil moisture and fertilization (Plants stressed for water or nutrients are more susceptible to and suffer greater damage from aphids).<br>• Use regular monitoring with yellow sticky traps.<br>• Use resistant varieties.<br>• Sanitation: Destroy weeds, crop residues and nearby leafy vegetable crop remains by disking, deep plowing and mowing.<br>• Avoid early planting.<br>• Avoid excessively high soil nitrogen levels.<br>• Use wheat varieties that are resistant to BYDV. | • Treatments with natural chemicals, if needed, can include narrow range oils.<br>• For high levels of BYDV, use pirimicarb, systemic synthetic insecticide seed treatments containing thiamethoxam (recommended for use during vegetative growth, not flowering) or imidacloprid (recommended for use during vegetative growth, not flowering). |
| Termites (*Microtermes obesi, Odontotermes obesus)* | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene. |

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| | | • Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| Green Stink Bug, *Shizaphis graminum* | • Many parasites and predators attack stinkbugs. Among the more common predators are lady beetles and their larvae, lacewing larvae and Syrphid fly larvae.<br>• Control weeds in and around the field.<br>• Reflective aluminum mulches will deter aphids from landing on plants. | • Agricultural oil, detergents and selective insecticides<br>• Can use malathion, imidacloprid (recommended for use during vegetative growth, not flowering), permethrin--do not allow to enter open water and get RUP training, thiamethoxam (recommended for use during vegetative growth, not flowering) |
| Cutworm, *Agrotis ipsilon* | • Caterpillar natural enemies include predators like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae. Parasitic wasps of *Trichogramma* species, *Copidosoma* species, *Apanteles* species, *Diadegma*, and *Hyposoter* species sting and parasitize eggs and larvae (some of these organisms are available commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of artisanal extracts of garlic or chili pepper.<br>• Use of organic biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, *Beauveria bassiana,* spinosad.<br>• Use of organic botanical insecticides like neem, pyrethrin.<br>• Use of synthetic pesticides containing indoxacarb, spinetoram, chlorantraniliprole. |
| Smuts and Bunts:<br>Stinking smut, *Tilletia caries* and *Tilletia foetida*<br>Loose smut, *Ustilago tritici*<br>Flag smut, *Urocystis tritici*<br>Wheat Karnal Bunt, *Tilletia indica*<br>Sorghum Grain Smut, *Sphacelotheca sorghi* | • Use certified smut-free seed.<br>• Hot water treatment can eliminate smut fungi from contaminated seed, but it must be used carefully to avoid reducing seed vitality.<br>• For covered smut, which is on the outside of the seed, treatment of seed with contact-type fungicides will control covered smut.<br>• For loose smut, which resides inside the seed, seed treatment with systemic fungicides is necessary. | • For seed treatment, use synthetic pesticides containing carboxin + thiram, tebuconazole or tebuconazole. |
| Wheat and Sorghum Powdery Mildews, *Blumeria graminis;* | • Use certified disease-free resistant hybrid seed.<br>• Resistant cultivars of barley and wheat are available. | • Although normally not economical, foliar fungicides containing propiconazole can be used to control disease outbreaks and |

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| *Perenospora sorghi* | • Crop rotation.<br>• Elimination of crop residue.<br>• Control of volunteer grains and weed hosts reduce inoculum survival from one season to the next. | provide partial disease control. To protect the flag leaf, applications should be made between tillering and heading. |
| Sorghum Anthracnose, *Colletotrichum sublineolum* | • Use resistant varieties available.<br>• Use only certified disease-free clean planting material.<br>• Monitor plants continuously and carefully for disease symptoms. | • Can use synthetic fungicides containing azoxystrobin, metiram, mancozeb, and thiabendazole. |
| Stalk rots: Maize and Sorghum Charcoal Rot (*Macrophomina phaseolini*); Fusarium stalk rot (*Fusarium verticillioides*); Pythium stalk rot (*Pythium aphanidermatum* and other *Pythium* species) | • Use resistant hybrids.<br>• Eliminate low areas in the field and improve drainage to prevent development of stalk rot.<br>• Good water management to avoid stressing plants, particularly as the crop approaches the flowering stage.<br>• Crop rotation to nonhost crops, such as small grains, can also help reduce the disease potential.<br>• Practice balanced fertility (do not over-fertilize, especially with nitrogen).<br>• Practice sanitation: plowing crop residues under at the end of the season. | • Generally, fungicides are not economical for use against stalk rots.<br>• For seed treatment, use synthetic pesticides containing carboxin + thiram.<br>• For plant disease, use synthetic pesticides containing triadimefon. |

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| Millet Downy Mildew, *Sclerospora graminicola* | • Promoting good drainage.<br>• Increasing spacing for better aeration.<br>• Controlling brassica-type weeds.<br>• Using resistant varieties.<br>• Rotating with non-cole crops.<br>• Sanitation: After harvest, deep plow or destroy plant debris.<br>• Avoid the use of overhead irrigation. | • Use of mineral copper for organic production.<br>• Use synthetic pesticide containing chlorothalonil, mefenoxam, or fosetyl aluminum. |
| Millet Cercospora Leaf Spot, *Cercospora penniseti* | • Varieties vary considerably in resistance, with the highest yielding current varieties having the least resistance.<br>• Growers planting millets in late fall or early spring for an early fall harvest are most likely to be affected by Cercospora and should use a more resistant variety if possible.<br>• To effectively eliminate inoculum from a field, plant millets in a 3-year rotation with nonhosts and plow to incorporate crop residues.<br>• Avoid planting a new millet field adjacent to fields planted to millets the previous season. | • Use synthetic fungicides containing copper compounds, carbendazim, propiconazole, azoxystrobin or tebuconazole. |
| Barley Yellow Dwarf Virus (BYDV) transmitted by Aphids (*Aphis* species) | • Use wheat varieties that are resistant to BYDV.<br>• Control aphid vectors.<br>• A number of coccinellid and syrphid predators, parasites and fungal diseases usually keep aphid populations below damaging levels.<br>• Maintain adequate soil moisture and fertilization (Plants stressed for water or nutrients are more susceptible to and suffer greater damage from aphids).<br>• Use regular monitoring, yellow sticky traps.<br>• Use resistant varieties.<br>• Sanitation: Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• Avoid early planting.<br>• Avoid excessively high soil nitrogen levels. | • Treatments with natural chemicals to control aphids, if needed, can include narrow range oils, pyrethrin and rotenone.<br>• For high levels of BYDV, use systemic synthetic insecticide seed treatments containing thiamethoxam (recommended for use during vegetative growth, not flowering) or imidacloprid (recommended for use during vegetative growth, not flowering).<br>• No synthetic pesticides are recommended for spraying. |
| Stem, leaf and stripe rusts: *Puccinia species* | • Use certified disease-free resistant hybrid seed.<br>• Resistant cultivars of barley and wheat are available. | • If new races of the fungus render current sources of resistance obsolete, fungicides such as propiconazole can be applied at 4 |

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| | | oz. per acre to control disease outbreaks. To protect the flag leaf, applications should be made between tillering and heading. |
| Weeds: | • Deploy integrated weed management.<br>• Adequate drainage is necessary for fields planted to small grains. Excessive moisture in low areas creates and aggravates problems such as stand loss, loss of soil nutrients, reduced oxygen supply, and root diseases. Chiseling the soil before seedbed preparation increases drainage and root development.<br>• Use pre-irrigation or first rain to germinate weed seeds and remove them by tilling before planting or by applying post emergent herbicides, land preparation.<br>• Under dryland conditions, after the first autumn rainfall, primary fall tillage with a disk, chisel plow, or moldboard plow usually follows to eliminate germinating winter weed seedlings. | • For fallow period, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I).<br>• Preplant, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I).<br>• Post-plant, wheat, before weeds emerge, use synthetic herbicides containing pendimethalin.<br>• Post-plant, wheat, after weeds emerge, use synthetic herbicides containing tralkoxydim, bromoxynil, fenoxaprop-P-ethyl (use only acute toxicity Classes II and III products; not Class I), mesosulfuron-methyl, carfentrazone, clopyralid, chlorosulfuron, pyraflufen-ethyl.<br>• Post-plant, barley, after weeds emerge, use synthetic herbicides containing tralkoxydim, bromoxynil, carfentazone, chlorosulfuron, fenoxaprop-P-ethyl (use only acute toxicity Classes II and III products; not Class I), and clopyralid.<br>• Post-plant oats, after weeds emerge, use synthetic herbicides containing bromoxynil, chlorosulfuron, carfentrazone, chlopyralid. |
| | **Warehouse Cereals/Small Grains Storage** | |
| Weevils: Rice weevil | • Do routine monitoring. Ensure good pest identification; | • If needed, can use insecticides containing |

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| (*Sitophilus oryzae*), Maize weevil (*Sitophilus zeamais*) | understand pest biology, ecology, and behavior.<br>• Use good sanitation and good grain storage practices, as follows:<br>• All grain stored off the floor on palates, with space between palates, well ventilated/aerated and lighted, dispose of old containers.<br>• In empty shipping containers, thoroughly sweep or brush down walls, ceilings, ledges, braces, and handling equipment, and remove all spilled debris.<br>• Brush, sweep out and/or vacuum the truck beds, augers, and loading buckets to remove insect-infested grain and debris.<br>• Remove all debris from fans, exhausts, and aeration ducts (also from beneath slotted floors, when possible).<br>• Remove all debris and vegetation growing within ten feet of the warehouses (preferably the whole storage area).<br>• Examine area to determine if rodent bait stations are required, and use if needed. Be sure to follow all label directions.<br>• Spray cleaned area around warehouse or bins with a residual herbicide to remove all undesirable weedy plants.<br>• Remove all debris from the storage site and dispose of it properly.<br>• Frequent rotation of the stocks, "FIFO" (First In - First Out) rule applies.<br>• Use sticky traps to monitor for presence and quantity. | spinosad or IGR methoprene, or synthetic pyrethroid insecticides containing deltamethrin, permethrin.<br>• Can fumigate (only with highly trained, equipped and certified applicators) using aluminum phosphide. |
| Khapra beetle (*Trogoderma granarium*) | • Sanitation/Cleaning all grain and food residues<br>• Removal of all packaging and empty grain/food bags<br>• Good aeration of commodities<br>• Pest identification important<br>• Knowledge of pest biology, ecology, and behavior<br>• Risk-benefit analyses<br>• Multiple management tactics<br>• Routine monitoring is first & foremost | • Use of wall and floor spraying with insecticides containing spinosad or IGR methoprene, or synthetic pyrethroid insecticides containing deltamethrin, permethrin.<br>• Can fumigate (only with highly trained, equipped and certified applicators) using aluminum phosphide. |
| Beetles:<br>Lesser/Brown grain beetle, *Rhyzopertha dominica*;<br>Dhora/pulse beetles,<br>*Callosobruchus chinensis; Callosobruchus maculatus;* | • Use good sanitation and good grain storage practices (see above). | • If needed, can use insecticides containing spinosad or IGR methoprene, or synthetic pyrethroid insecticides containing deltamethrin, permethrin.<br>• Can fumigate (only with highly trained, equipped and certified applicators) using aluminum phosphide. |

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| Confused Flour Beetle, *Tribolium confusum* | | |
| Grain moth larvae: Indian meal moth (*Plodia interpunctella*), Angoumois grain moth (*Sitotroga cerealella*)<br>Rice moth<br>(*Corcyra cephalonica*) | • Use good sanitation and good grain storage practices (see above).<br>• Temperature extremes will kill moths.<br>• Use pheromone traps for monitoring. | • Use natural pesticide containing BT or diatomaceous earth.<br>• Use carbon dioxide fumigation. If needed, can use insecticides containing spinosad or IGR methoprene, or synthetic pyrethroid insecticides containing deltamethrin, permethrin.<br>• Can fumigate (only with highly trained, equipped and certified applicators) using aluminum phosphide. |
| Secondary pests (feed on grain dust, flour, but not on whole grains):<br>Saw-toothed grain beetle (*Oryzaephilus surinamensis*)<br>Red flour beetle<br>(*Tribolium casteneum*) | • Use good sanitation and good grain storage practices (see above). | • Use carbon dioxide fumigation.<br>• If needed, can use insecticides containing spinosad or IGR methoprene, or synthetic pyrethroid insecticides containing deltamethrin, permethrin.<br>• Can fumigate (only with highly trained, equipped and certified applicators) using aluminum phosphide. |
| Rodents: Rats, Mice | • Use good sanitation and good grain storage practices (see above).<br>• Use mechanical or sticky traps for capture and disposal by burying.<br>• Find and flood burrows with water. | • Use bait boxes with approved rodenticide cubes inside. |
| **Oil Seed Crop: Rape Seed/Canola; Mustard** | | |
| Aphids:<br>Turnip aphid<br>(*Lipaphis erysimi*)<br>Mustard aphid,<br>*Brevicoryne brassicae* | • Use of "habitat plantings" (flowering perennial plants that attract aphid parasitoids and predators.<br>• Carefully manage nitrogen levels so that they are neither too high (which significantly attracts aphids) nor too low (which impedes plant growth).<br>• Natural enemies that can be attracted to fields with habitat plantings include aphid and syrphid flies, lacewings, and the predaceous midge, minute pirate bugs, big-eyed bugs, lady beetles, soldier beetles, and parasitic wasps like *Diaeretiella rapae*.<br>• In some humid areas there are outbreaks of naturally existing fungi | • Organically accepted insecticides include those containing insecticidal soap, neem, and pyrethrum.<br>• Use synthetic pesticides containing acetamiprid (recommended for use during vegetative growth, not flowering), spirotetramat, thiamethoxam (recommended for use during vegetative growth, not flowering) or pymetrozine. |

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| | that cause epidemics among aphid colonies.<br>• When plants are young and leaf cupping has not yet occurred, high-pressure overhead sprinkler irrigation dislodges aphids.<br>• Inter-planting with clover (as a "living mulch") reduces aphid populations. | |
| Painted bug<br>(*Bagrada cruciferarum*) | • Use crop rotation.<br>• Sanitation: Do crop residue destruction by plowing or burning. | • Spraying with plant extracts garlic, onion, chili pepper. |
| Mustard saw fly<br>(*Athalia lugens*) | • Several natural parasites and predators control sawflies.<br>• Use sawfly resistant cultivars.<br>• Use crop rotation.<br>• Delay planting of spring mustards.<br>• Sanitation: Use shallow fall tillage to destroy and burry crop stubble. | • Use natural pesticides containing BT.<br>• Use synthetic pesticides containing malathion. |
| Termite<br>(*Odontotermes obesus*) | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| Powdery mildew<br>*Erysiphe cruciferarum* | • Use resistant varieties.<br>• Do proper plant spacing; do not crowd plants.<br>• Use slow-release fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support). | • Can use natural fungicides containing sulfur, oils. |
| Alternaria leaf spot/blight<br>*Alternaria spp* | • Use resistant varieties.<br>• Keep the field well-drained.<br>• Transplant only healthy plants. | • Can use synthetic fungicides containing azoxystrobin or chlorothalonil. |
| Downy mildew<br>*Peronospora parasitica* | • Use clean, certified seed.<br>• Rotating with non-host crops.<br>• Deeply incorporating plant debris.<br>• Avoid overhead irrigation. | • Use synthetic pesticide containing chlorothalonil. |

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| White rust<br>*Albugo candida* | • Crop rotation with noncruciferous host plants is effective.<br>• Practice weed and cruciferous weed control.<br>• Avoid overhead irrigation.<br>• Avoid planting in fields having a history of white rust problems; soil borne oospores may result in severe disease.<br>• Reducing leaf moisture by avoiding sprinkler irrigation will not prevent white rust, but keeping leaves dry may reduce disease severity.<br>• Sanitation: Plowing or disking diseased plants and plant parts results in rapid decomposition of infected tissues and helps to significantly reduce future white rust infection. | • Use of mineral fixed copper and wettable sulfur for organic production.<br>• Use synthetic pesticide containing chlorothalonil, mefenoxam, metalaxyl or fosetyl aluminum. |
| **Oil Seed Crop: Groundnut/Peanut** | | |
| Termites:<br>Scavenging termite,<br>*Odontotermes obesus*<br>White Ant termite,<br>*Microtermes obesi* | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| Caterpillars:<br>Hairy caterpillar<br>*Diacrisia oblique*<br>Red Hairy caterpillar<br>*Amsacta spp* | • Use resistant varieties.<br>• Handpick larvae. | • If needed, use pesticides containing neem, or spinosad. |
| Cut worm<br>*Spodoptera litura* | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating. | • Use of artisanal extracts of garlic or chili pepper, neem and natural biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, spinosad.<br>• Use of synthetic pesticides containing indoxacarb, chlorantraniliprole. |

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| | • Use of floating row screen or mesh covers to exclude egg-laying moths. | |
| Grasshopper<br>*Chrotogonus spp* | • Naturally controlled by nematodes.<br>• Handpick and destroy if not too many.<br>• Scout for breeding sites to detect outbreaks.<br>• Some poison baits are available to attract and kill grasshoppers. | • Spray with a natural myco pesticide containing Metharizium when nymphs are seen on weeds or the crop.<br>• Spray with dimethoate or malathion insecticide if damage seems likely. |
| Peanut early leaf spot<br>(*Cercospora arachidicola*) | • Use resistant varieties.<br>• Soil pH should range from 5.8-6.2 with the optimum at 6.0.<br>• Sanitation—plow deep to burry plant residues.<br>• Do not irrigate during cool weather.<br>• Do not injure plants when hoeing.<br>• Rotate crops. | • Can spray copper and sulfur containing compounds. |
| Late leaf spot<br>*Phaeoisariopsis personata* | • Use resistant varieties.<br>• Sanitation—plow deep to burry plant residues. | • Can use seed treated with *Trichoderma harzianum*.<br>• Can use synthetic fungicides containing mancozab and carbendazim. |
| Seed rot and seedling blight<br>*Rhizopus arrhizus*<br>*Aspergillus niger*<br>*Panicillium sp* | • Use resistant varieties.<br>• Do not plant seed too deep; use recommended seeding depth. | • Use seed treated with carbendazim or thiram.<br>• Use a fungicide containing mancozeb if symptoms appear. |
| **Oil and Seed Crops: Sunflower; Safflower; Sesame; Linseed** | | |
| Okra jassid/leafhopper<br>(*Amrasca biguttula*) | • Control weeds and monitor during the summer to determine the need to treat.<br>• Predation by spiders can provide significant reduction of leafhopper populations. | • Use of carbaryl provides some control. |
| Caterpillars:<br>Sesame Tiger moth/Bihar hairy caterpillar,<br>*Spilosoma oblique*; *Euproctis scintillans*;<br>Sesame Leaf Roller, | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control tiger moth larvae. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of floating row screen or mesh covers to exclude egg-laying | • Use of artisanal extracts of garlic or chili pepper, neem and natural biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT *and* spinosad.<br>• Use of synthetic pesticides containing indoxacarb, chlorantraniliprole. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| *Antigastra catalaunalis*<br>Linseed and Sunflower Caterpillar, *Diacrisia oblique* | moths. | |
| White fly (*Bemisia tabaci*) | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 white fly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering). |
| Cotton aphid (*Aphis gossypii*) | • Many natural enemies and parasites control aphids.<br>• Eliminate ant colonies near field.<br>• Do not over-apply nitrogen fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Aluminum foil or gray mulches deter aphids. | • Natural insecticides containing insecticidal soap, neem oil, and paraffin oil provide temporary control.<br>• Use synthetic insecticides containing malathion or permethrin. |
| Armyworm (*Spodoptera spp*) | • Natural enemies include parasitoid Braconid and Cotesia wasps and Tachinid flies as well as damsel bugs, ground beetles, lacewings and weaver ants.<br>• Practice proper field sanitation. Destroy weeds from bordering fields and on field borders. Remove weeds regularly to reduce breeding sites and shelter for armyworm. Remove all plant debris after harvesting.<br>• Plow and harrow field thoroughly. Sometimes, the small grains or grasses are plowed-under after the eggs are laid on them. As the field is planted and the plants begin to grow, the larvae will continue to develop and will start attacking the plants.<br>• Early warning mechanism e.g. use of pheromone traps to detect adult flight patterns can pre-empt major damage | • Botanical and homemade water extracts include basil, chili, garlic, neem and lemongrass.<br>• Sprays of natural pesticides *Bacillus thuringiensis aizawai* and spinosad.<br>• Use synthetic pesticides containing spinetoram and synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | • During outbreaks it is absolutely necessary to use pesticides to control invading caterpillars | |
| Cotton bollworm (*Helicoverpa armigera*) | • Many predators and parasites attack cotton bollworm eggs, including several species of *Trichogramma.* General predators include lacewings, minute pirate bugs, and damsel bugs eat corn earworm eggs and small larvae.<br>• Monitor fields regularly.<br>• Sanitation: Do crop residue destruction. | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and the Entrust formulation of spinosad.<br>• Use synthetic pesticides containing spinetoram and synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |
| *Mealy bug (Phenacoccus solenopsis)* | • Introduced wasps and predatory mites generally control most outbreaks of mealy bug | • Use synthetic insecticides containing dimethoate. |
| Cutworm (*Agrotis ipsilon*) | • Caterpillar natural enemies (keep populations down) include predators like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae. Parasitic wasps of *Trichogramma* species, *Copidosoma* species, *Apanteles* species, *Diadegma*, and *Hyposoter* species sting and parasitize eggs and larvae (some of these organisms are available commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of artisanal extracts of garlic or chili pepper.<br>• Use of organic biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, spinosad.<br>• Use of organic botanical insecticides like neem.<br>• Use of synthetic pesticides containing indoxacarb, spinetoram, chlorantraniliprole. |
| Termite (*Odontotermes obesus*) | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Hairy caterpillar (*Diacrisia oblique*) | • Use resistant varieties.<br>• Handpick larvae. | • If needed, use pesticides containing BT neem, or spinosad. |
| Turnip moth larvae (*Agrotis segetum*) | • See recommendations above under wheat | • See recommendations above. |
| Sunflower charcoal rot<br>*Macrophomina phaseolina* | • Use resistant hybrids.<br>• Eliminate low areas in the field and improve drainage to prevent development of stalk rot.<br>• Good water management to avoid stressing plants, particularly as the crop approaches the flowering stage.<br>• Crop rotation to nonhost crops, such as small grains, can also help reduce the disease potential.<br>• Practice balanced fertility (do not over-fertilize, especially with nitrogen).<br>• Practice sanitation: plowing crop residues under at the end of the season. | • For seed treatment, use synthetic pesticides containing carboxin + thiram.<br>• For plant disease, use synthetic pesticides containing triadimefon. |
| Sunflower vertcillium wilt<br>*Verticillium spp* | • Use resistant varieties.<br>• Do weed control.<br>• Sanitation: remove and destroy crop residues after harvest. | • Use of fungicides is not economical. |
| Sunflower/rapeseed alternaria blight<br>*Alternaria spp* | • Use resistant varieties.<br>• Do weed control.<br>• Do crop rotation.<br>• Sanitation: remove and destroy crop residues after harvest. | • Can use fungicides containing pyraclostrobin. |
| Rapeseed powdery mildew (*Oidium* species) | • Use resistant varieties.<br>• Provide good air circulation. | • Use natural controls containing paraffin oils, neem oil, potassium bicarbonate and sulfur. |
| Canola/mustard downy mildew<br>*Peronospora parasitica* | • Use resistant varieties.<br>• Use drip irrigation before dusk. | • Use synthetic fungicides containing metalaxyl, azoxystrobin, and copper. |
| Sesame root rot<br>*Rhizoctonia phaseoli*<br>*Macrophomina spp* | • Use resistant varieties.<br>• Can treat soil with mycorrhizae. | • Use natural *Trichoderma* species as a biofungicide.<br>• Use synthetic fungicides containing carbendazim. |

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| Linseed wilt<br>*Fusarium oxysporum* | • Use resistant cultivars and seed treatments.<br>• Disinfect tools and, if possible, steam clean equipment between uses and fields.<br>• Rotate out of linseed.<br>• Use sanitation—remove and burn heavily infected plants, and crop residues at season end.<br>• Use lime to raise soil pH.<br>• Use of chicken manure and mushroom compost decrease disease symptoms.<br>• Use soil solarization (heating under black plastic for 3 months) to kill spores. | • No synthetic fungicides are recommended for spraying. |
| Weeds | • Control measures include the use of resistant cultivars with obligatory crop rotation.<br>• Perform thorough land preparation (soil tillage, fertilizer, and water management).<br>• Narrow row spacing makes the crop more competitive than the weeds, use intercropping.<br>• Place the fertilizer in such a way that the crop has access to it but the weeds do not. This allows the crop to be more competitive with weeds.<br>• Maintain cleanliness on the irrigation canals.<br>• Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitats for natural enemies.<br>• Regularly clean farm tools.<br>• Use green manure which chokes out weeds.<br>• Use intercropping.<br>• Hand weeding and composting (do not compost weeds that have flowered and set<br>• Hoeing, mowing, and cutting. | • Can use synthetic herbicide containing imazapic.<br>• Can use herbicides containing fluchloralin at 2.0 l/ha before sowing and incorporate or apply as pre-emergence spray on 5 day after sowing followed by irrigation or apply pendimethalin as pre-emergence spray 3 days after sowing. |
| | **Sugar Crop: Sugarcane** | |
| Stem Borers:<br>Sugarcane stem borer<br>*Chilo infuscatellus* | • Use borer-resistant varieties.<br>• Natural enemies of larvae include parasitoids Braconid family of parasitic wasps, wasps of the genus Cotesia, and Tachinid fly larvae. *Trichogramma* parasitoids attack eggs of stalk borers. Predators | • Between the egg stage and leaf-feeding stage (before they bore into the stem), use natural pesticides containing BT toxin or spinosad (both extracts from |

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| Sugarcane top borer<br>*Scirpopbaga novella*<br><br>Gurdaspur borer<br>*Acigona steniellus* | include ground beetles, lacewing larvae and adults, praying mantis and weaver ants.<br>• Sanitation: Remove and destroy stalks by burning, feeding to cattle or composting. Plow deeply and harrow. | soil microbes) or synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or chlorpyrifos-ethyl, bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |
| Sugarcane root borer<br>*Emmalocera depressella* | • Sanitation: During early season, remove and destroy plants with dead-heart or dry-top.<br>• Ensure that crop is sufficiently fertilized and irrigated. | • Use natural insecticides containing bacteria *Bacillus thuringiensis*. |
| Sugarcane Pyrilla,<br>*Pyrilla perpusilla;*<br>Sugarcane Black Bug,<br>*Cavelerius excavates* | • Use yellow sticky traps early in season for monitoring and control.<br>• Sanitation: Remove and destroy all crop residues. | • If control is needed, use products containing paraffin oil, acetamiprid (recommended for use during vegetative growth, not flowering), or pymetrozine. |
| Termites<br>*Microtermes obesi*<br>*Odontotermes guptai* | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| Sugarcane white flies<br>*Aleurolobus barodensis*<br>*Neomaskellia bergii* | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 white fly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering). |
| Sugarcane Mealy bugs, | • Field borders should be kept clean of weeds and debris that may | • Use of agricultural oil to control ants |

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| *Saccharicoccus sacchari; Phenacoccus saccharifolii; Heterococcus rehi* | support mealy bugs between plantings.<br>• Sanitation: Eliminate crop residues, weeds and grass roots.<br>• Remove and destroy ant nests. | that protect mealy bugs. |
| Red rot<br>*Colletotrichum falcatum = Glomerella tucumanensis* | • Use resistant varieties.<br>• Promote efficient soil drainage.<br>• Sanitation: Remove all diseased plants during season and crop residues after harvest.<br>• Practice prompt harvesting. | • Treat propagation materials with hot water or fungicide prior to planting.<br>• Foliar fungicide applications are not effective or economical. |
| Sugarcane smut/whip smut<br>*Ustilago scitaminea* | • Use resistant varieties and clean propagation materials.<br>• Sanitation: Remove all diseased plants during season and crop residues after harvest. | • No fungicides are recommended. |
| Grassy shoot phytoplasma | • Use healthy, certified disease-free seed sets.<br>• Remove and destroy diseased plants throughout the season.<br>• Moist hot air treatment of seed sets may reduce infection. | • No pesticides are recommended, unless control of an insect vector is needed. |
| Pineapple disease<br>*Ceratocystis paradoxa* | • Use resistant varieties.<br>• Plant when conditions favor rapid germination.<br>• Use crop rotation away from cane.<br>• Promote efficient soil drainage. | • Propagation material can be treated with fungicides containing propinconazole. |
| Sugarcane Mosaic Virus | • Use resistant varieties and certified disease free seed cane propagation materials.<br>• Treat propagation materials with hot water prior to planting.<br>• Reduce aphid vectors by trapping and controlling weeds in and around the field.<br>• Sanitation: dig out and removed heavily infected plants if infection rate is below 5% in the field. | • No chemicals are recommended. |
| | **Sugar Crop: Sugar Beets** | |
| Grasshopper (*Cirulifer tenellus*) | • Usually controlled in nature by a large number of natural enemies, but not in "outbreak" years.<br>• Monitor field edges closely for outbreaks. | • If outbreaks occur, use synthetic insecticides containing carbaryl. |
| Cutworm (*Agrotis ipsilon*) | • Monitor damage by counting damaged and freshly cut young plants. Monitor cutworm at dawn on field margins.<br>• Sanitation: Destroy weeds in and around field.<br>• Remove and destroy cutworms. | • Can use synthetic insecticides containing carbaryl, but spray cutworm hotspots (areas with many cutworms), not the entire field. |

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| | • Prepare field and remove weeds well ahead (10-14 days) of planting the crop in the field. Plowing exposes caterpillars to predators and to desiccation by the sun. If the field is planted soon after land preparation some cutworms may be alive and attack the new crop. | |
| Aphid (*Pemphigus betae*) | • A fungus and a fly larva generally provide good control of sugar beet aphid.<br>• Use proper irrigation and avoid water stress.<br>• Sanitation: Clean up and destroy all weeds (especially redroot pigweed and lambsquarters) and in and around field and beet roots left in field after harvest.<br>• Crop rotation: Rotate out of sugar and table beets, spinach and chard for 3 years.<br>• Clean all equipment and implements before moving from an infested to a noninfested field. | • No pesticides are recommended for this aphid species. |
| Whitefly (*Bemisa tabaci*) | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 white fly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering). |
| Beet root rot (*Rhizoctonia solani*) and *Fusarium* species | • There may resistant varieties available.<br>• Follow good tillage, irrigation and fertilization practices to promote good crop vigor and maintain adequate soil drainage.<br>• Plant sugar beet in rotation with corn or small grains, and when cultivating, avoid throwing dirt into plant crowns.<br>• Sanitation: Remove weeds in and around field and destroy crop residues after harvest. | • No fungicides are recommended. |
| Cercospora leaf spot (*Cercospora* species) | • Varieties vary considerably in resistance, with the highest yielding current varieties having the least resistance. | • Use synthetic fungicides containing copper compounds, carbendazim, |

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| | • Growers planting beets in late fall or early spring for an early fall harvest are most likely to be affected by Cercospora and should use a more resistant variety if possible.<br>• To effectively eliminate inoculum from a field, plant beets in a 3-year rotation with nonhosts and plow to incorporate crop residues. Avoid planting a new beet field adjacent to fields planted to beets the previous season.<br>• When sprinkler irrigation is used, run sets so that windblown mist does not keep leaves wet for longer than 24 hours. | propiconazole, azoxystrobin or tebuconazole. |
| Zonate leaf spot (*Phoma betae*) | • Use resistant varieties and clean, certified or hot-water treated seed.<br>• Ensure good soil drainage.<br>• Sanitation: Remove and destroy weeds and crop residues at end of season.<br>• Use of Trichoderma as a soil treatment reduces Phoma. | • Spraying periodically with copper oxychloride is recommended. |
| Sclerotium root rot<br>*Sclerotium rolfsii* | • Management can be best achieved by reducing inoculum buildup through crop rotation. Suggested crops to include in a rotation are alfalfa, wheat, barley, corn, or susceptible crops that do not require irrigation during warm weather conditions.<br>• Do not rotate beets with beans or other highly susceptible crops and avoid frequent irrigations during hot weather.<br>• Yield losses can be reduced through application of nitrogenous fertilizers that promote vigorous growth (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Additionally, in fields where Sclerotium root rot has been identified, harvest early. | • There are no chemical control methods for managing this disease. |
| | **Amaranthus Crop: Spinach** | |
| Armyworms, *Spodoptera* species | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize | • Use of artisanal or commercial extracts of garlic or chili pepper, neem.<br>• Use of natural biopesticides or microbial controls consisting of *Bacillus* |

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| | eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | *thuringiensis*/BT *and* spinosad. |
| Semilooper, *Trichoplusia* species | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths.<br>• Use of organic herbal repellents like those extracted from garlic (Cropguard, Garlic Barrier) or red chili peppers. | • Use of natural biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, *Beauveria bassiana*, spinosad.<br>• Use of organic botanical insecticides like neem, pyrethrin. |
| American Bollworm, *Helicoverpa armigera* | • Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma.* General predators include lacewings, minute pirate bugs, and damsel bugs eat corn earworm eggs and small larvae.<br>• Monitor fields regularly | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and neem/azadirachtin or the Entrust formulation of spinosad.<br>• Use synthetic pesticides containing spinetoram or lambda cyhalothrin (use formulations 10% and below). |
| Broad Mites, *Polyphagotarsonemus latus* | • Ensure proper irrigation.<br>• Monitor regularly. | • Use insecticidal soap, horticultural and neem oils or abamectin (use formulations below 1.9%). |
| Spinach Anthracnosis, *Colletotrichum* species | • Use certified disease free seed.<br>• Irrigation: avoid overhead sprinkler irrigation; if overhead irrigation is done, do only during the day so that plants can dry out.<br>• Maintain adequate fertilization. | • Use copper hydroxide (use only Class II and III products, not Class I). |

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| Spinach Downy Mildew, *Peronospora effusa* | • Use monitoring.<br>• Use resistant varieties.<br>• Use clean certified seed, rotation, and raised-bed.<br>• Do not plant near other crops susceptible to mildew.<br>• Irrigation: avoid overhead irrigation; if overhead irrigation is done, do only during the day so that plants can dry out.<br>• Maintain good soil drainage practices. | • If necessary, use protectant products in the following synthetic fungicides chlorothalonil, metalaxyl, fosetyl-aluminum, tebuconazole, trifloxystrobin, propiconazole, and iprodione. |
| **Pulses: Chickpea; Lentils** | | |
| Termite<br>*Odontotermes guptai* | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing thiamethoxam (recommended for use during vegetative growth, not flowering), chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| Grasshopper<br>*Chrotogonus spp* | • Naturally controlled by nematodes.<br>• Handpick and destroy if not too many.<br>• Scout for breeding sites to detect outbreaks.<br>• Some poison baits are available to attract and kill grasshoppers. | • Spray with a natural myco pesticide containing Metharizium when nymphs are seen on weeds or the crop.<br>• Spray with dimethoate or malathion insecticide if damage seems likely. |
| Caterpillars:<br>Armyworm<br>*Spodoptera exigua*<br>Hairy Lentil Caterpillar,<br>*Diacrisia oblique* | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of artisanal or commercial extracts of garlic or chili pepper, neem.<br>• Use of natural biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT *and* spinosad.<br>• Use of synthetic pesticides containing indoxacarb, chlorantraniliprole. |

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| Aphids<br>*Aphis spp* | • Use crop rotation with cereals following lentils.<br>• Do scouting and monitoring to determine pest presence, quantity and damage.<br>• Sanitation: Cut and destroy crop residues by burning or burying. | • Use synthetic insecticide seed treatment containing thiamethoxam (recommended for use during vegetative growth, not flowering). |
| Gram pod borer<br>*Helicoverpa armigera* | • Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma*. General predators include lacewings, minute pirate bugs, and damsel bugs eat corn earworm eggs and small larvae.<br>• Monitor fields regularly | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and neem/azadirachtin or the Entrust formulation of spinosad.<br>• Use synthetic pesticides containing spinetoram or lambda cyhalothrin (use formulations 10% and below). |
| Cut worm<br>*Agrotis ipsilon* | • Use crop rotation with cereals following lentils.<br>• Do scouting and monitoring to determine pest presence, quantity and damage.<br>• Use pheromone traps to monitor.<br>• Sanitation: Cut and destroy crop residues by burning or burying.<br>• Do weed control in and around field. | • Apply insecticides in early morning or late day when cutworms are active.<br>• Use synthetic insecticide containing permethrin. |
| Chickpea semi-looper<br>*Autographa nigrisigna* | • Many natural enemies effectively control looper populations.<br>• For plots of 2 hectares or less, loopers can be handpicked. | • Insecticide sprays are rarely required and not generally recommended. |
| Leaf miner<br>*Liriomyza cicerina* | • Natural enemies, especially parasitic wasps in the genus Diglyphus, commonly reduce populations of leafminers.<br>• Sanitation: Post-harvest, disc under crop residues.<br>• Do not plant next to spinach. | • Can use natural sprays of neem oil.<br>• Can use synthetic insecticide containing abamectin (use formulations below 1.9%). |
| Lentil pod borer<br>*Etiella zinckenella* | • Many natural enemies control pod borers.<br>• Field sanitation: Removal of infested material. | • Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering).<br>• Spray on insecticides containing systemic synthetic insecticides imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid |

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| | | (recommended for use during vegetative growth, not flowering) or synthetic pyrethroids like deltamethrin, esfenvalerate, bifenthrin (use only 10% EC and 2.5% ULV formulations), beta cyfluthrin (use formulations 10% and below), or lambda cyhalothrin (use formulations 10% and below). |
| Weevils:<br>Chickpea Bruchid, *Callosobruchus species*<br>Lentil Beetle, *Bruchus lentis* | • Use crop rotation with cereals following lentils.<br>• Do scouting and monitoring to determine pest presence, quantity and damage.<br>• Sanitation: Cut and destroy crop residues by burning or burying. | • Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering).<br>• Insecticides containing systemic synthetic insecticides imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or synthetic pyrethroids like deltamethrin, esfenvalerate, bifenthrin (use only 10% EC and 2.5% ULV formulations), beta cyfluthrin (use formulations 10% and below), or lambda cyhalothrin (use formulations 10% and below). |
| Chickpea blight (*Ascochyta rabiei*) | • Use resistant certified clean seed that is treated.<br>• Use crop rotation with cereals following lentils. Rotate out of legume crops for 3-4 years.<br>• Do proper agronomic practices: seedbed preparation, weed control, seed handling, date of planting, row spacing.<br>• Rhizobium inoculation for nitrogen production. | • Use synthetic fungicide seed treatment of carboxin, fludioxonil and mefenoxam.<br>• Can use synthetic fungicides containing chlorothalonil, mancozeb, pyraclostrobin or azoxystrobin. |
| Seed and root rots (*Fusarium* species, *Pythium* species, | • Use certified clean seed that is treated.<br>• Use crop rotation with cereals following lentils. Rotate out of | • Use synthetic fungicide seed treatment of mefenoxam, thiram, carboxin + |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| *Rhizoctonia* species) | legume crops for 3-4 years.<br>• Rhizobium inoculation for nitrogen production.<br>• Sanitation: Cut and destroy crop residues by burning or burying.<br>• Do proper agronomic practices: seedbed preparation, weed control, seed handling, date of planting, row spacing. | thiram, fludioxonil and mefenoxam.<br>• Can use synthetic fungicides containing chlorothalonil, mancozeb, pyraclostrobin or azoxystrobin. |
| Sclerotinia white mold (*Sclerotinia sclerotiorum*) | • Use certified clean seed that is treated.<br>• Use crop rotation with cereals following lentils. Rotate out of legume crops for 3-4 years.<br>• Rhizobium inoculation for nitrogen production.<br>• Do proper agronomic practices: seedbed preparation, weed control, seed handling, date of planting, row spacing. | • Use synthetic fungicide seed treatment of mefenoxam, thiram, carboxin + thiram, fludioxonil and mefenoxam.<br>• Can use synthetic fungicides containing chlorothalonil, mancozeb, pyraclostrobin or azoxystrobin. |
| Collar rot<br>*Sclerotium rolfsii* | • Management can be best achieved by reducing inoculum buildup through crop rotation with alfalfa, wheat, barley, corn, or susceptible crops that do not require irrigation during warm weather conditions.<br>• Avoid frequent irrigations during hot weather.<br>• Yield losses can be reduced through application of nitrogenous fertilizers that promote vigorous growth (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Additionally, in fields where Sclerotium root rot has been identified, harvest early.<br>• Use deep plowing to burry sclerotia. | • There are no chemical control methods for managing this disease. |
| Pea leaf-rolling virus | • Use certified disease-free seed. | • There are no chemical control methods for managing this disease. |
| Botrytis grey mold on lentils<br>*Botrytis cinerea* | • Do regular monitoring for gray mold.<br>• Use sanitation: Clean up and destroy crop residues.<br>• Avoid over-head sprinkler irrigation. | • Can use natural fungicides containing neem oil, *Bacillus subitlis*, or potassium bicarbonate.<br>• Can use synthetic fungicides containing chlorothalonil. |
| Pulses: Mashbean; Mashbean; Urdbean; Green peas; Beans; Mungbean | | |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Gram pod borer<br>*Heliotbis armigera* | • Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma.* General predators include lacewings, minute pirate bugs, and damsel bugs eat corn earworm eggs and small larvae.<br>• Monitor fields regularly | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and the Entrust formulation of spinosad.<br>• Use synthetic pesticides containing spinetoram. |
| White fly<br>*Bemisia tabaci* | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering).<br>• Insecticides containing systemic synthetic insecticides imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or synthetic pyrethroids like deltamethrin, esfenvalerate, bifenthrin (use only 10% EC and 2.5% ULV formulations), beta cyfluthrin (use formulations 10% and below), or lambda cyhalothrin (use formulations 10% and below). |
| Aphids:<br>Bean aphid (*Aphis fabae*)<br>Cowpea aphid (*Aphis craccivora*) | • Use crop rotation with cereals following lentils.<br>• Do scouting and monitoring to determine pest presence, quantity and damage.<br>• Sanitation: Cut and destroy crop residues by burning or burying. | • Use synthetic insecticide seed treatment containing spinosad, pymetrozine or thiamethoxam (recommended for use during vegetative growth, not flowering).<br>• Insecticides containing systemic synthetic insecticides imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | | for use during vegetative growth, not flowering) or synthetic pyrethroids like deltamethrin, esfenvalerate, bifenthrin (use only 10% EC and 2.5% ULV formulations), beta cyfluthrin (use formulations 10% and below), or lambda cyhalothrin (use formulations 10% and below). |
| Cutworm<br>*Agrotis ipsilon* | • Use crop rotation with cereals following pulses.<br>• Do scouting and monitoring to determine pest presence, quantity and damage.<br>• Use pheromone traps to monitor.<br>• Sanitation: Cut and destroy crop residues by burning or burying.<br>• Do weed control in and around field. | • Apply insecticides in early morning or late day when cutworms are active.<br>• Use synthetic insecticide containing permethrin. |
| Bugs:<br>Painted bug<br>*Bagrada hilaris*<br>Green bug<br>*Nezara viridula* | • Many natural predators and parasitoids control bugs.<br>• Do not cut all nearby alfalfa fields at the same time as bugs will move from the cut alfalfa to pulses, en masse.<br>• Destroy weeds (legumes, thistles, mustards, and mallows) that are good overwintering hosts for adult stink bugs around fields | • Do not use broad-spectrum insecticides that will kill natural enemies that are controlling the bugs.<br>• Can use kaolin clay & insecticidal soap sprays are acceptable for use on organically certified produce.<br>• Can use synthetic insecticides containing dimethoate or acephate.<br>• Insecticides containing systemic synthetic insecticides imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or synthetic pyrethroids like deltamethrin, esfenvalerate, bifenthrin (use only 10% EC and 2.5% ULV formulations), beta cyfluthrin (use formulations 10% and below), or lambda cyhalothrin (use formulations 10% and below). |
| Pod borer | • Many predators and parasites attack corn earworm eggs, including | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and the Entrust |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| *Helicoverpa armigera* | several species of *Trichogramma*. General predators include lacewings, minute pirate bugs, and damsel bugs eat corn earworm eggs and small larvae.<br>• Monitor fields regularly. | formulation of spinosad.<br>• Use synthetic pesticides containing spinetoram. |
| Caterpillars:<br>Army worm<br>*Spodoptera letura*<br>Mashbean/Mungbean Hairy Caterpillar, *Diacrisia obliqua* | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of artisanal or commercial extracts of garlic or chili pepper, neem.<br>• Use of natural biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, spinosad.<br>• Use of synthetic pesticides containing indoxacarb, chlorantraniliprole. |
| Termite<br>*Odontotermes guptai* | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| Grasshopper<br>*Chrotogonus spp* | • Naturally controlled by nematodes.<br>• Handpick and destroy if not too many.<br>• Scout for breeding sites to detect outbreaks.<br>• Some poison baits are available to attract and kill grasshoppers. | • Spray with a natural myco pesticide containing dimethoate or malathion insecticide if damage seems likely. |
| Cercospora leaf spot<br>*Cercospora canescens* | • Use disease-free seed.<br>• Treat seed with hot water at 54degrees C for 10 minutes.<br>• Use crop rotation. | • Use synthetic fungicides containing mancozeb or carbendazim. |
| Anthracnose<br>*Colletotrichum lindemuthianum* | • Use disease free seed.<br>• If presence confirmed practice 7-year crop rotation.<br>• Follow strict field sanitation.<br>• Avoid sprinkler irrigations when fruit begins to ripen. | • Fungicides are generally not required, however, if desired, use synthetic fungicides containing copper, azoxystrobin, chlorothalonil, mancozeb. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Powdery mildew of peas<br>*Erysiphe polygoni (pisi)* | • Use resistant varieties.<br>• Do proper plant spacing; do not crowd plants.<br>• Use slow-release fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support). | • Can use natural fungicides containing sulfur, paraffin oils. |
| Bacterial leaf spot<br>*Xanthomonas campestris* | • Use certified disease-free seed.<br>• Avoid sprinkler irrigations when fruit begins to ripen.<br>• Practice a 2-3 year rotation out of beans. | • Bactericidal sprays are generally not effective or economical. |
| Viruses:<br>Mungbean yellow mosaic virus<br>Urdbean leaf crinkle virus | • Use resistant varieties.<br>• Locate bean fields far away from perennial legumes (alfalfa, clover, and vetch). | • No pesticides are available. |
| **Warehouse Dry Bean Storage Pests** | | |
| Seed and stem weevils<br><br>Cowpea weevil: *Callosobruchus maculates*;<br>Broad bean weevil: *Bruchus rufimanus*;<br>Bean weevil: *Acanthoscelides obtectus* | • Do routine monitoring. Ensure good pest identification; understand pest biology, ecology, and behavior.<br>• Use good sanitation and good grain storage practices, as follows:<br>• All grain stored off the floor on palates, with space between palates, well ventilated/aerated and lighted, dispose of old containers.<br>• In empty shipping containers, thoroughly sweep or brush down walls, ceilings, ledges, braces, and handling equipment, and remove all spilled debris.<br>• Brush, sweep out and/or vacuum the truck beds, augers, and loading buckets to remove insect-infested grain and debris.<br>• Remove all debris from fans, exhausts, and aeration ducts (also from beneath slotted floors, when possible).<br>• Remove all debris and vegetation growing within ten feet of the warehouses (preferably the whole storage area).<br>• Remove and dispose of all beans and debris remaining in planting machine or harvester, cull beans for animal feed, small piles of beans in field and close partial sacks of bean planting seed.<br>• Examine area to determine if rodent bait stations are required, and use if needed. Be sure to follow all label directions.<br>• Spray cleaned area around bins with a residual herbicide to remove all undesirable weedy plants.<br>• Remove all debris from the storage site and dispose of it properly. | • If needed, can use insecticides containing spinosad or IGR methoprene, or synthetic pyrethroid insecticides containing deltamethrin, permethrin.<br>• Can fumigate (only with highly trained, equipped and certified applicators) using aluminum phosphide. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | • Frequent rotation of the stocks, "FIFO" (First In - First Out) rule applies.<br>• Use sticky traps to monitor for presence and quantity. | |
| Rodents: Rats, Mice | • Use good sanitation and good grain storage practices (see above).<br>• Use mechanical or sticky traps for capture and disposal by burying.<br>• Find and flood burrows with water. | • Use bait boxes with approved rodenticide cubes inside. |
| | **Solanaceous Crops: Tomato; Potato; Chiles** | |
| White flies (*Bemisia tabaci, Trialeurodes vaporariorum*) | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Yellow sticky traps may be used to reduce populations but cannot prevent the spread, once established.<br>• Frequent crop monitoring. | • Spray natural solution of local soap or paraffin oil if infestation is heavy.<br>• At crop initiation, seed or soil application of a synthetic systemic nicotinoid insecticide imidacloprid (recommended for use during vegetative growth, not flowering) or acetamiprid (recommended for use during vegetative growth, not flowering).<br>• Selective synthetic chemicals as: Azadirachtin, Insect Growth Regulator pyriproxyfen, abamectin (use formulations below 1.9%). |
| Tomato Fruitworm (*Helicoverpa = Heliothis armigera)* | • Avoid planting crops successively that are hosts to tomato fruitworm like corn, cotton, sorghum, tobacco and soybean.<br>• *Trichogramma* wasps from the bio laboratory provide some control of tomato fruitworm eggs.<br>• Two weeks before planting, remove weeds and grasses to destroy earworm larvae and adults harboring in those weeds and grasses.<br>• Practice crop rotation.<br>• Plow, disc and harrow fields at least 2 times before sowing seeds. This exposes pupae of tomato fruitworm (tomato fruitworm pupates in the soil) to chickens, birds, ants and other predators.<br>• Make and use pheromone or light traps.<br>• Begin sampling soon after fruit development. Eggs hatch in 5 to 7 days following egg laying. | • Insecticidal control of tomato fruitworm is difficult and depends on proper timing and thorough coverage. Once larvae enter the tomato, control with insecticides is difficult; direct insecticidal control towards young larvae that are feeding on the fruit, before entering it.<br>• Natural sprays of *Bacillus thuringiensis (BT)* and spinosad. |
| Cutworm species | • Natural enemies include larvae of parasitic Braconid wasps and | • Use sprays of BT. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| (*Agrotis segetum*) | Tachinid flies. Predators include ground beetles, lacewings, praying mantis and weaver ants.<br>• Use crop rotation--plant alfalfa or beans after tomato.<br>• Removal of weeds in and around fields will reduce egg-laying sites and will help in the prevention of cutworm infestation.<br>• Use pheromone traps.<br>• Interplant main crops with onion, garlic, peppermint, coriander, or garlic every 10-20 rows to repel cutworms.<br>• Sunflowers and cosmos can also be planted as a trap crop in or around fields.<br>• Plow and harrow fields properly before planting. This will destroy eggs and expose larvae to chicken, ants, birds, and other predators. | • Find 'hot-spots' (places of high infestation) and treat only those hotspots with synthetic insecticides containing carbaryl, chlorpyrifos and permethrin. |
| Armyworm (*Spodoptera litura*) | • Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of artisanal extracts of garlic or chili pepper.<br>• Use of natural biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT *and* spinosad.<br>• Use of organic botanical insecticides like neem.<br>• Use of synthetic pesticides containing indoxacarb, chlorantraniliprole. |
| Potato tuber worm moth (*Phthorimaea operculella)* | • Use pheromone traps.<br>• Shallow setting varieties are generally more susceptible than varieties that set tubers deep.<br>• Any practice that reduces the exposure of tubers to egg-laying female moths will reduce tuberworm damage.<br>• Prevention of soil cracking in the beds will reduce tuberworm damage. Thus, Furrow-irrigated fields have a much greater potential to become infested than sprinkler-irrigated fields (cracking of the soil is less severe under sprinkler irrigation than with furrow irrigation).<br>• Prompt, thorough harvest and sanitation are also essential.<br>• Sanitation: Destroy cull piles and volunteer potatoes. Piles of cull | • Use natural sprays of spinosad.<br>• Use synthetic insecticides containing indoxacarb. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | potatoes provide a year-round breeding site for tuberworm. | |
| Aphids (*Aphis craccivora*, *Myzus persicae* and other species) | • Many types of natural enemies and pathogens may control these aphids under low insecticide input situations. However, these aphids reproduce quickly and move into protected areas of the plants, thereby greatly reducing the potential impact of their predators and parasitoids in older stage plants.<br>• Use resistant varieties.<br>• Use regular monitoring with yellow sticky traps.<br>• Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops. | • If control is needed, treat when aphids are found to be reproducing, particularly when second and later generation wingless females have started reproduction. Aphid populations are easier to control before the plants begin to cup.<br>• Insecticides containing systemic synthetic insecticides imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or pymetrozine can be used. |
| Hadda leaf beetle<br>(*Henosepilachna sparsa* = *Epilachna sparsa*) | • Use resistant varieties.<br>• Sanitation: Destroy crop residues after season.<br>• Do post-season tillage to reduce overwintering sites and beetles. | • Use natural neem/azadirachtin extracts. |
| Mealy bugs:<br>Striped mealy bug,<br>*Ferrisia virgata*<br>Tomato Mealy bug,<br>*Phenacoccus solenopsis* | • Natural parasitic wasps and predators such as lady beetle adults and larvae, lacewings adults and larvae, minute pirate bugs and spiders can control mealy bugs.<br>• Do regular monitoring, note taking and mapping of mealybug infestations.<br>• Control honeydew-seeking ants using tillage and common vetch cover crops.<br>• Peel back the thin bark on spurs in the current season's prunings and look for the presence of mealy bug crawlers (larvae); if 20% of samples show crawlers apply a delayed dormant insecticide. | • In the summer, treatments can include insecticides containing dimethoate or buprofezin. |
| Grasshopper<br>*Chrotogonus trachypterus* | • Naturally controlled by nematodes.<br>• Handpick and destroy if not too many.<br>• Scout for breeding sites to detect outbreaks.<br>• Some poison baits are available to attract and kill grasshoppers. | • Spray with a natural myco pesticide containing Metharizium when nymphs are seen on weeds or the crop.<br>• Spray with dimethoate or malathion insecticide if damage seems likely. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Tomato Root Knot Nematode, *Meloidogyne* species<br><br>Potato Cyst Nematode, *Globodera rostochiensis* | • Use of resistant cultivars and grow healthy plants (use appropriate seed, spacing, watering, weeding and fertilizer)<br>• Use Soil solarization using plastic.<br>• Use crop rotation, deep plowing, fallowing and avoid mono cropping. Rotate with broccoli, cauliflower, sorghum, Sudan grass, rape, and mustard seed which are resistant to nematodes.<br>• Sanitation: Remove and compost crop debris.<br>• Use of organic fertilizer particularly chicken manure and composts to add organic matter and soil structure to sandy soils<br>• Growing flax, a tropical herb, is good for controlling root knot nematodes.<br>• African and French marigold (*Tagetes minuta* and *T. patula,* respectively) attract and can be used to trap nematodes. But, 2 months after planting, marigolds must be dug up with roots, and destroyed, or they will serve as a source of inoculation. | • Management of nematodes is difficult, especially in sandy soils.<br>• Botanical and homemade water extracts of basil, garlic and neem seed may be effective controls.<br>• Two new commercialized products, once registered for use, can be used as effective nematode controls: the microbe *Myrothecium verrucaria* and natural soil biopesticide labeled as Promax (containing extracts of tomatillo oil and thyme oil) |
| Late Blight, *Phytophthora infestans* | • Use tolerant varieties.<br>• Drain the growing area adequately before planting.<br>• Follow proper planting date; do not plant late.<br>• Farmers use sticks and lines to raise tomato plants and fruit into the air to aerate the plant and raise the leaves and fruit away from the soil. | • Use synthetic fungicides containing azoxystrobin, copper sulfate, mancozeb, chlorothalonil, dimethomorph, pyraclostrobin. |
| Tomato Bacterial Brown Rot, *Pseudomonas solanacearum* and Bacterial Wilt, *Ralstonia solanacearum* | • Use raised-bed production and monitor soil moisture.<br>• Sufficiently drain the growing field<br>• Monitor the field frequently and remove dead and dying plants that are full of inoculum. | • Can use combinations of bacteriocide copper hydroxide (use only Class II and III products, not Class I) with mancozeb (which increases the efficacy of copper). |
| Wet rot and storage rots | • *Thoroughly* clean and disinfect storage facilities and handling equipment prior to receiving seed potatoes.<br>• Clean and disinfect set-cutters and planters between seed lots.<br>• Practice crop rotation.<br>• Apply a seed piece dressing to minimize disease carry-over.<br>• Plant good quality seed potatoes that appear to be disease free. | • Use a fungicide containing mefenoxam and chlorothalonil. |
| Dry rot<br>*Fusarium spp* | • Allow tubers to mature before harvest.<br>• Prevent bruising tubers during harvest and storage operations. | • On potato seed, use fungicides containing fludioxonil, and thiophanate- |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | | methyl + mancozeb. |
| Fusarium wilt<br>*Fusarium spp* | • Use healthy seedlings<br>• Use resistant varieties.<br>• Remove solanaceous weeds.<br>• Avoid infected fields.<br>• Controlled burning on fields.<br>• Use clean seedbeds (subsoil nurseries, solarization).<br>• Practice rotation with non-solanaceous crops (minimum 5 years).<br>• Sanitation: Destroy whole plan and root after harvest. | • Use fungicides containing mancozeb and chlorothalonil. |
| Early blight (*Alternaria solani*) | • Maintain good soil drainage.<br>• Grow later maturing, longer season varieties. | • Use fungicides containing mancozeb, pyraclostrobin and chlorothalonil. |
| Leaf spot<br>*Cercospora* = *Mycovellosiella concors* | • Use resistant varieties.<br>• Sanitation: Destroy whole plan and root after harvest. | • Use Bordeaux mix. |
| Fruit rots<br>Tomato, *Alternaria tenuis*<br>Chili pepper, *Alternaria tenuissima* | • Use resistant varieties.<br>• Sanitation: Destroy crop residues. | • No fungicides are recommended. |
| Anthracnose in chili peppers (*Colletotrichum capsici*) | • Use resistant cultivars.<br>• Use disease-free seed and seedlings.<br>• Sanitation: Throughout season remove diseased seedlings.<br>• Control weeds and solanaceous weeds in field.<br>• Manage water moisture and avoid planting in water-logged soil. | • Use synthetic fungicides containing azoxystrobin, trifloxystrobin, chlorothalonil, copper, difenoconazole and carbendizim. |
| Chili pepper powdery mildew<br>*Leveillula taurica* | • Use of resistant seeds.<br>• Transplanting healthy plants.<br>• Use pesticides only when it necessary.<br>• Sanitation: Pruning and burn old leaves, branches. | • If necessary, use protectant products in the following fungicide families: copper, mancozeb, azoxystrobin, metalaxyl, chlorothalonil, and fosetyl-aluminum. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Chili Veinal Mottle Virus, vectored by aphids | • Use resistant varieties.<br>• Strict sanitation by removal of diseased plants, especially before fruit set<br>• Remove weeds (solanaceous) as alternate host.<br>• Ensure balanced nutrition<br>• Manage aphid vector populations by controlling weeds in field and putting yellow sticky traps on field edges. | • Few insecticides can control aphids before they transmit the virus to chilies.<br>• Aphid stylet oil may be useful in reducing transmission of this potyvirus. |
| Potato Leaf Roll Virus, vectored by aphids | • Use certified disease free seed tubers.<br>• Control Nightshades and other alkaloid-producing plants near the field.<br>• Remove volunteer potatoes containing the virus early in the season.<br>• Manage aphid vector populations by controlling weeds in field and putting yellow sticky traps on field edges. | • Few insecticides can control aphids before they transmit the virus to chilies.<br>• Aphid stylet oil may be useful in reducing transmission of this potyvirus. |
| Chili Bacterial Wilt (*Ralstonia solanacearum*) | • Use raised-bed production and monitor soil moisture.<br>• Sufficiently drain the growing field<br>• Monitor the field frequently and remove dead and dying plants that are full of inoculum. | • Can use combinations of bacteriocide copper hydroxide (use only Class II and III products, not Class I) with mancozeb (which increases the efficacy of copper). |
| Weeds | • Herbicide expenses make farmers use hand weeding, hoeing or cultivation.<br>• At end of the harvest, manual removal of weeds.<br>• Clean weeds along irrigation canals that can transmit weeds to the field.<br>• Use crop rotation.<br>• Use transplants which can out-compete weeds quicker.<br>• Use soil solarization.<br>• Use soil mulches and pruning.<br>• Continue hoe and hand weeding.<br>• Can use drip irrigation to regulate water in the crop and avoid weed emergence. | Tomato<br>• In fall beds, before weeds emerge, use synthetic herbicides containing metribuzin, oxyfluorfen.<br>• After weeds emerge, use glyphosate (use only acute toxicity Classes II and III products; not Class I).<br>• Pre-plant before weeds emerge, use synthetic herbicides containing trifluralin, pendimethalin.<br>• Post-plant after weeds emerge, use synthetic herbicides containing clethodim, metribuzin.<br>Potato<br>• Pre- and Post-plant, use synthetic |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | | herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I), pendimethalin. |
| | **Solanaceous: Eggplant/Brinjal** | |
| Borers:<br>Brinjal shoot borer<br>*Euzophera perticella*<br>Brinjal fruit borer<br>*Helicoverpa armigera* | • Grow the varieties with long and narrow fruits in endemic areas.<br>• Collect and destroy the damaged and dead plants.<br>• Install pheromone and light traps at 1/ha to attract and kill adults.<br>• Remove and destroy the affected tender shoots, fallen fruits and fruits with bore holes.<br>• Avoid continuous cropping of brinjal crop. | • Use natural insecticides containing BT or neem.<br>• Avoid using synthetic pyrethroids.<br>• Use synthetic insecticides containing acetamiprid, imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering). |
| Brinjal lacewing bug<br>*Urentius sentis* | • Use resistant varieties.<br>• Do crop rotation away from brinjal and potato.<br>• Sanitation: Remove and destroy heavily-infested plants or parts. | • Use synthetic insecticides containing dimethoate. |
| Greasy cutworm<br>*Agrotis ipsilon* | • Caterpillar natural enemies (keep populations down) include predators like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae. Parasitic wasps of *Trichogramma* species, *Copidosoma* species, *Apanteles* species, *Diadegma*, and *Hyposoter* species sting and parasitize eggs and larvae (some of these organisms are available commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of artisanal extracts of garlic or chili pepper.<br>• Use of organic biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, spinosad.<br>• Use of organic botanical insecticides like neem.<br>• Use of synthetic pesticides containing indoxacarb, spinetoram, chlorantraniliprole. |
| Hadda beetle<br>*Eiplachna demurili* | • Use resistant varieties.<br>• Sanitation: Destroy crop residues after season.<br>• Do post-season tillage to reduce overwintering sites and beetles. | • Use natural neem/azadirachtin extracts. |
| Whitefly, *Bemisia tabaci* | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | finding 1 white fly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering). |
| Mealy bug, *Phenacoccus solenopsis* | • Natural parasitic wasps and predators such as lady beetle adults and larvae, lacewings adults and larvae, minute pirate bugs and spiders can control mealy bugs.<br>• Do regular monitoring, note taking and mapping of mealy bug infestations.<br>• Control honeydew-seeking ants using tillage and common vetch cover crops. | • Treatments can include insecticides containing dimethoate or buprofezin. |
| Weeds | • Herbicide expenses make farmers use hand weeding, hoeing or cultivation.<br>• At end of the harvest, manual removal of weeds.<br>• Clean weeds along irrigation canals that can transmit weeds to the field.<br>• Use crop rotation.<br>• Use transplants which can out-compete weeds quicker.<br>• Use soil solarization.<br>• Use soil mulches and pruning.<br>• Continue hoe and hand weeding.<br>• Can use drip irrigation to regulate water in the crop and avoid weed emergence. | • On preformed beds, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I), carfentrazone.<br>• Post-plant, use synthetic herbicides containing clethodim, carfentrazone. |
| **Cole Crops/Crucifer/Brassicas: Cabbage, Cauliflower, Broccoli** | | |
| Caterpillars:<br>Cabbage semi looper<br>*Plusia orichalcea*<br>Cabbage butterfly | • Caterpillar natural enemies (keep populations down) include predators like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae. Parasitic wasps of *Trichogramma* species, *Copidosoma* species, *Apanteles* species, *Diadegma*, and *Hyposoter* species sting and parasitize eggs | • Use of organic biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT, the insect-eating fungus, bacterial extracts like spinosad, and living caterpillar viruses. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| *Pieris brassicae*<br>Cabbage webworm<br>*Hellula undalis* | and larvae (some of these organisms are available commercially).<br>• Use of organic herbal repellents like those extracted from garlic, red chili peppers or neem oil.<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of pheromone misters and emitters to disrupt mating.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • Use of organic botanical insecticides like neem combined with diatomaceous earth.<br>• Use of synthetic pesticides containing indoxacarb, spinetoram, chlorantraniliprole, methoxyfenozide. |
| Diamond back moth<br>*Plutella spp* | • For monitoring, use light traps over soap dish to control adult stages and monitoring insect population's dynamics.<br>• Sticky bright yellow or blue traps will help to trap and control adult stages.<br>• Crop rotation with non-susceptible hosts.<br>• Use of trap crops such as inter-planted or edge-planted mustards (but monitor and destroy plants before adults are produced).<br>• Mating disruption with sex pheromones has been shown to be effective in reducing diamondback moth populations in Florida.<br>• Sprinkle irrigation may reduce the number of caterpillars in the field; if it is applied at dusk, it may limit the activity of adults. | • Use of natural biological control with *Trichogramma* species, *Metharizium anisopliae*, *Bacillus thuringiensis* and neem applications.<br>• Use the Insect Growth Regulator (IGR).<br>• Rotate synthetic insecticides containing abamectin (use formulations below 1.9%), imidacloprid (recommended for use during vegetative growth, not flowering) or indoxacarb. |
| Cabbage aphid<br>*Myzus pursicae* | • Use of "habitat plantings" (flowering perennial plants that attract aphid parasites and predators.<br>• Carefully manage nitrogen levels so that they are neither too high (which significantly attracts aphids) or too low (which impedes plant growth).<br>• Natural enemies that can be attracted to fields with habitat plantings include aphid and syrphid flies, lacewings, and the predaceous midge, minute pirate bugs, big-eyed bugs, lady beetles, soldier beetles, and parasitic wasps like *Diaeretiella rapae*.<br>• In some humid areas there are outbreaks of naturally existing fungi that cause epidemics among aphid colonies.<br>• When plants are young and leaf cupping has not yet occurred, high pressure overhead sprinkler irrigation dislodges aphids.<br>• Inter-planting with clover (as a "living mulch") reduces aphid populations.<br>• Use trap crops: Plant mustards or collards on field margins or inter- | • Organically accepted insecticides include those containing insecticidal soap, neem and pyrethrum.<br>• Use synthetic pesticides containing acephate, acetamiprid (recommended for use during vegetative growth, not flowering), spirotetramat, chlorpyrifos, or pymetrozine. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | planted and destroy these plants once heavily infested. | |
| Clubroot (*Plasmodiophora brassicae)* | • If soil pH is lower than 7.2, use lime to increase the pH.<br>• Use resistant varieties if available.<br>• Use crop rotation to non-cole crops for several years.<br>• Control brassicaceous weeds near field.<br>• Manage drainage so soil does not water-log. | • No chemicals are recommended. |
| Black leg (*Phoma lingam)* | • Clean, certified or hot-water treated seed.<br>• Good soil drainage.<br>• Rotation with non-brassica type crops.<br>• Control of brassica-type weeds.<br>• Deep incorporation of cole crop residues.<br>• Planting resistant varieties. | • No chemicals are recommended. |
| Fusarium yellows (*Fusarium oxysporum* f. *conglutinans)* | • Resistant varieties.<br>• Good drainage.<br>• Soil-building practices such as cover crops and compost are recommended. | • No chemicals are recommended. |
| Sclerotinia white rot (*Sclerotinia sclerotiorum* and *Sclerotinia minor)* | • Good drainage and irrigation practices that reduce humidity in fields can reduce the disease.<br>• Deep plowing is often recommended, but the results are temporary and very disruptive to soil microorganisms. | • Biological controls include the fungus *Coniothyrium minitans*, which attacks sclerotia. *Coniothyrium* is available commercially in the product Contans™, from Sylvian Bioproducts, Inc.<br>• No synthetic pesticides are recommended. |
| Black rot (*Xanthomonas campestris)* | • Rotation.<br>• Weed control.<br>• Thorough debris incorporation.<br>• The use of clean seed.<br>• Application of approved copper products. | • No synthetic pesticides are recommended. |
| Downy mildew (*Peronospora parasitica)* | • Promoting good drainage.<br>• Increasing spacing for better aeration.<br>• Controlling brassica-type weeds.<br>• Using resistant varieties.<br>• Rotating with non-cole crops.<br>• Sanitation: After harvest, deep plow or destroy plant debris. | • Use of mineral copper for organic production.<br>• Use synthetic pesticide containing chlorothalonil, mefenoxam, or fosetyl aluminum. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | • Avoid the use of overhead irrigatio | |
| Alternaria leaf spot (*Alternaria brassicae* and/or *Alternaria brassicola)* | • Using clean, certified seed,<br>• Rotating with non-host crops,<br>• Deeply incorporating plant debris,<br>• Avoiding overhead irrigation,<br>• Promoting air circulation in the canopy. | • Use synthetic pesticide containing chlorothalonil. |
| Weeds | • Monitor and identify weed species present.<br>• Use fallow practices.<br>• Sanitation: To reduce seed production, disc or mow harvested fields before weeds flower and produce seeds. Cultivation equipment and irrigation water must also be kept free of weed seeds and vegetative propagates to avoid spreading weed populations. Cultivate areas around the field such as field edges, fence lines, roadsides, and irrigation ditches regularly to prevent weed seed production. To reduce seed production, disc or mow harvested fields before weeds flower and produce seeds.<br>• Preplant plowing, followed by irrigation and one or two discings before bed formation, will destroy many weeds.<br>• Proper bed preparation is important for successful weed cultivation after the crop is planted.<br>• Regularly clean farm tools.<br>• Use green manure, which chokes out weeds.<br>• Use intercropping.<br>• Hand weeding during their earlier growing period. Do not let the weeds flower (do not compost weeds that have flowered and set seed).<br>• Hoeing, mowing, and cutting. | • During fallow, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I).<br>• Pre-plant, before weeds emerge, use synthetic herbicides containing trifluralin. |
| **Cucurbits: Cucumbers; Squashes; Pumpkins; Melons; Watermelon** | | |
| Red pumpkin beetle<br>*Aulacophora spp* | • Sanitation: Destroy crop residues after season.<br>• Do post-season tillage to reduce overwintering sites and beetles. | • Use natural neem/azadirachtin extracts. |
| Hadda beetle<br>*Epilachna spp* | • Sanitation: Destroy crop residues after season.<br>• Do post-season tillage to reduce overwintering sites and beetles. | • Use natural neem/azadirachtin extracts. |

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| Fruit fly<br>*Dacus cucurbitae* | • If needed, purchase and introduce parasitoids to the orchard.<br>• Baited (with methyl eugenol) traps can be used to monitor the presence and control the flies.<br>• Fruit fly adults feed on honeydew. Reducing black scale populations may reduce a food source needed during high summer temperatures.<br>• Sanitation: Collect and burry all dropped fruits. | • The use of sprays/dusts of kaolin clay or diatomaceous earth and baited (GF-120 Fruit Fly Bait) traps are acceptable for use in an organically certified crop. |
| Aphid<br>*Aphis spp* | • Use resistant varieties<br>• Use regular monitoring with yellow sticky traps<br>• Many types of natural enemies and pathogens may control these aphids under low insecticide input situations.<br>• Sanitation: Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• If control is needed, treat when aphids are found to be reproducing, particularly when second and later generation wingless females have started reproduction. Aphid populations are easier to control before the plants begin to cup. | • Foliar contact insecticides have limited impact as plants enter the cupping stage.<br>• While insecticides may help reduce secondary spread of aphid-transmitted viruses, they do not prevent primary infection of fields.<br>• Synthetic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or pymetrozine can be used. |
| Cutworm<br>*Agrotis spp* | • Use weed management by cultivation in and around field.<br>• Irrigate to speed germination and emergence of the crop.<br>• Monitor to determine where infestations are heavy.<br>• Sanitation: Destruction of plant residues from previous crops and avoiding planting in fields that are coming out of pasture. | • Monitor and use spot treatments (apply where cutworms heavily infested, not the entire field) of synthetic insecticides containing indoxacarb, carbaryl. |
| Red vegetable mite<br>*Tetranychus telarius* | • Natural predators and parasites control large proportions of spider mite populations. The western predatory mite, *Galendromus (=Metaseiulus) occidentalis,* can be purchased and released onto field.<br>• Apply water to reduce dust on roads in the vineyard. Maintain resident vegetation or other cover in the vineyard middles to further reduce dust.<br>• Irrigate in a manner that will avoid plant stress. Overhead watering has been shown to reduce mite problems, but it can increase some diseases. | • Can use natural insecticides containing paraffin oils, neem oil and insecticidal soap.<br>• Can use synthetic insecticides containing propargite, fenpyroximate, pyridaben, hexythiazox, and dicofol. |
| Downy mildew<br>(*Pseudoperonospora cubensis)* | • Resistant varieties are available for control.<br>• Avoid overhead irrigation. | • Use synthetic pesticide containing mancozeb + metalaxyl, chlorothalonil, |

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| | • Apply a fungicide when disease symptoms first occur and repeat if symptoms worsen. | cyazofamid, flupicolide), mefenoxam, cymoxanil, maneb. |
| Powdery mildew (*Sphaerotheca fuliginea, Erysiphe cichoracearum)* | • Control irrigation water.<br>• Resistant varieties are available for control.<br>• Use crop rotation.<br>• Sanitation: Remove and destroy dead plants.<br>• Control weeds in and around field.<br>• Increase light intensity by planting at proper recommended intervals. | • Use natural fungicide containing cinnamaldehyde, potassium bicarbonate or micronized sulfur.<br>• Use synthetic fungicides containing triflumizole, myclobutanil, pyraclostrobin, azoxystrobin, trifloxystrobin, and kresoxym-methyl. |
| Cucumber Mosaic Virus (CMV) transmitted by aphids. | • Control aphids that transmit CMV.<br>• Use silver reflective mulches to repel aphids that transmit CMV. | • Control vector aphids (see above). |
| Root-knot nematodes (*Meloidogyne* species) | • Practice crop rotation.<br>• Remove and destroy heavily damaged plants.<br>• Disinfect cultivation equipment regularly and especially between fields.<br>• Apply fire ash near newly planted cucumbers. | • No nematicides are recommended. |
| Weeds | • Cultivate weeds under before they set seed in rotation crops.<br>• Pre-irrigate before planting crop and cultivate or spray weeds that emerge.<br>• Plant or transplant cucurbits into uniform beds and use a precision planting system that puts crop in straight line that will allow cultivation close to the seed line.<br>• Use mulches to smother weeds near plants. | • Before planting, treatment with synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I), carfentrazone, oxyfluorfen.<br>• At planting use synthetic herbicides containing ethalfluralin (use only acute toxicity Classes II and III products; not Class I).<br>• After planting use synthetic herbicides containing clethodim.<br>• For layby use synthetic herbicides containing trifluralin or ethalfluralin (use only acute toxicity Classes II and III products; not Class I). |
| **Okra** | | |
| Bollworms: | • Observe parasitation and predators (ants, bugs). | • As soon as young caterpillars are seen, |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Spotted bollworm<br>*Earias vittella* | • Use trap crops such as pigeon pea (*Cajanus cajan*) and Crotalaria to reduce bollworm attack. | spray with pyrethnoids or neem extracts. |
| Red spider mite<br>*Tetranychus cinnabarinus* | • Crop monitoring<br>• Plant away the other mite host plants.<br>• Destroy weeds and host crops as soon as possible, including the head rows.<br>• Always monitor before treatment with miticides. | • Can use natural miticides containing soap, paraffin oil, neem or spinosad (applied with good coverage to leaf undersides).<br>• Can use synthetic miticides containing abamectin (use formulations below 1.9%). |
| Whitefly<br>*Bemisia tabaci* | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 white fly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering). |
| Mealy bug, *Phenacoccus solenopsis* | • Natural parasitic wasps and predators such as lady beetle adults and larvae, lacewings adults and larvae, minute pirate bugs and spiders can control mealy bugs.<br>• Do regular monitoring, note taking and mapping of mealy bug infestations.<br>• Control honeydew-seeking ants using tillage and common vetch cover crops. | • Treatments can include insecticides containing dimethoate or buprofezin. |
| Jassid/leafhopper<br>*Amrasca devastans* | • Control grassy weeds and monitor during the summer to determine the need to treat.<br>• Predation by spiders can provide significant reduction of leafhopper populations.<br>• Use resistant plant varieties and avoid staggered planting | • Can use synthetic insecticides containing carbaryl. |
| Charcoal root rot<br>*Macrophomina phaseolina* | • Practice good soil water management.<br>• Avoid soil compaction. | • Can use synthetic fungicides containing thiophanate-methyl, thiram. |

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| | • Used raised-bed production.<br>• Rotate crops. | |
| Okra Leaf Curl Virus, transmitted by whiteflies | • Ensure strict sanitation by removal and destruction of diseased plants.<br>• Removal of possible weed host plants.<br>• Whiteflies are controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 whitefly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce whitefly populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, paraffin oil, neem oil if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering). |
| Root Knot Nematode, *Meloidogyne* species | • Use of resistant cultivars and grow healthy plants (use appropriate seed, spacing, watering, weeding and fertilizer)<br>• Use Soil solarization using plastic.<br>• Use crop rotation, deep plowing, fallowing and avoid mono cropping. Rotate with broccoli, cauliflower, sorghum, Sudan grass, rape, and mustard seed which are resistant to nematodes.<br>• Sanitation: Remove and compost crop debris.<br>• Use of organic fertilizer particularly chicken manure and composts to add organic matter and soil structure to sandy soils<br>• Growing flax, a tropical herb, is good for controlling root knot nematodes.<br>• African and French marigold (*Tagetes minuta* and *T. patula,* respectively) attract and can be used to trap nematodes. But, 2 months after planting, marigolds must be dug up with roots, and destroyed, or they will serve as a source of inoculation. | • Management of nematodes is difficult, especially in sandy soils.<br>• Botanical and homemade water extracts of basil, garlic and neem seed may be effective controls.<br>• Two new commercialized products, once registered for use, can be used as effective nematode controls: the microbe *Myrothecium verrucaria* and natural soil biopesticide labeled as Promax (containing extracts of tomatillo oil and thyme oil). |
| | **Alliums: Onion; Garlic** | |
| Thrips (*Thrips tabaci, Frankliniella occidentalis*) | • Biological controls with beneficial organisms include pink lady beetles, green lacewing larvae, minute pirate bugs, predatory mites and ladybugs.<br>• Crop rotation: Alternating crops with bean, corn or other crop.<br>• Blue sticky traps for monitoring. | • Natural extracts of neem, garlic, spinosad and insecticidal soaps are alternatives to other insecticides.<br>• Use synthetic insecticide containing spinetoram. |

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| | • Good irrigation, drainage and fertilization.<br>• Use a thrips-resistant cultivar such as Grano or Sweet Spanish.<br>• Grow onions during the rainy season and use overhead irrigation. | |
| Caterpillars:<br>American Bollworm, *Helicoverpa armigera*<br>Armyworm,<br>*Spodoptera litura*<br>Cutworm, *Agrotis ipsilon* | • Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma.* General predators include lacewings, minute pirate bugs, and damsel bugs eat caterpillar eggs and small larvae.<br>• Monitor fields regularly.<br>• Sanitation: Do crop residue destruction. | • Use natural sprays of *Bacillus thuringiensis (BT)* Kurtaski and the Entrust formulation of spinosad, spinetoram.<br>• Use synthetic pesticides containing spinetoram and synthetic pyrethroids like deltamethrin, esfenvalerate, beta cyfluthrin (use formulations 10% and below), or bifenthrin (use only 10% EC and 2.5% ULV formulations) or lambda cyhalothrin (use formulations 10% and below). |
| Aphids, *Myzus persicae* | • Use resistant varieties<br>• Use regular monitoring with yellow sticky traps<br>• Many types of natural enemies and pathogens may control these aphids under low insecticide input situations. However, these aphids reproduce quickly and move into protected areas of the plants, thereby greatly reducing the potential impact of their predators and parasitoids in older stage plants.<br>• Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• If control is needed, treat when aphids are found to be reproducing, particularly when second and later generation wingless females have started reproduction. Aphid populations are easier to control before the plants begin to cup. | • Can use insecticides available for post-emergence foliar treatments. Contact insecticides have limited impact as plants enter the cupping stage.<br>• Can use natural insecticide containing neem oil/azadirachtin or paraffin oil.<br>• Can use systemic synthetic insecticides s containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or pymetrozine.<br>• Can spray with synthetic insecticides containing thiamethoxam (recommended for use during vegetative growth, not flowering). |
| Garlic and Onion Rust, *Puccinia allii = porri* | • Rotate away from *Allium* crops for 2 to 3 years.<br>• Sanitation: Remove and destroy volunteer *Allium* plants during fallow periods or when other crops are planted. | • Use synthetic fungicides containing difenoconazole, mancozeb, propineb, or triadimefon. |

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| Garlic Powdery Mildew, *Oidiopsis sicula* | • Plastic mulch covering to avoid plant leaf contact with soil and minimize weeds that enhance microclimate conditions favorable to disease dispersion.<br>• Heat treatment of bulbs at 35 to 40 °C for 4 to 8h reduces the disease significantly.<br>• Eliminate crop residues, plant during dry season, and avoid irrigation during heat of the day.<br>• Use crop rotation.<br>• Use certified seed and good drainage. | • Bulb dipping with a synthetic fungicide containing metalaxyl.<br>• Use synthetic pesticide as soil drench and spray applications containing of chlorothalonil, thiophanate methyl, metalaxyl + mancozeb followed by oxadixyl + copper oxychloride. |
| Downy mildew (*Peronospora destructor*) | • Plastic mulch covering to avoid plant leaf contact with soil and minimize weeds that enhance microclimate conditions favorable to disease dispersion.<br>• Heat treatment of bulbs at 35 to 40 °C for 4 to 8h reduces the disease significantly.<br>• Eliminate crop residues, plant during dry season, and avoid irrigation during heat of the day.<br>• Use crop rotation.<br>• Use certified seed and good drainage. | • Bulb dipping with a synthetic fungicide containing metalaxyl.<br>• Use synthetic pesticide as soil drench and spray applications containing of chlorothalonil, thiophanate methyl, metalaxyl + mancozeb followed by oxadixyl + copper oxychloride. |

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| Weeds | • Use the most weed-free field possible.<br>• To avoid buildup of weed seed in the soil, cultivate weeds before they set seed in rotation crops.<br>• Clean cultivate the field or plant a green manure crop to limit weed infestations after onion harvest.<br>• Irrigate the field before planting to germinate weed seeds and afterwards cultivate the soil killing the weeds.<br>• After pre-irrigation, cultivate shallow so that weed seed is not brought up from deeper soil layers. Maintaining deep furrows keeps the bed tops from becoming overly wet while maintaining adequate soil moisture for the crop (by keeping the bed tops drier, fewer weeds are likely to germinate in the soil surface).<br>• To avoid excessive competition with the onions and to make removal easier, cultivate when weeds are small. Hand weeding is a very efficient method for weed control.<br>• Use soil solarization. | • At pre-plant, use synthetic herbicide containing glyphosate (use only acute toxicity Classes II and III products; not Class I).<br>• At post-plant before weeds and crop emerge, use a synthetic herbicide containing pendimethalin, oxyfluorfen, fluazifop-P-butyl, clethodim. |
| **Rhizome Spices: Ginger; Turmeric** | | |
| Shoot Borer, *Conogethes* = *Dichocrocis punctiferalis* | • Many natural enemies control shoot borer.<br>• Use pheromone or light traps to catch adult moths. | • Use neem extract azadirachtin.<br>• |
| Rhizome Scale, *Aspidiotus hartii* | • Field borders should be kept clean of weeds and debris that may support scales between plantings.<br>• Sanitation: Eliminate crop residues, weeds and grass roots.<br>• Remove and destroy ant nests. | • Use of agricultural oil to control ants that protect scales. |

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| Leaf Roller, *Udaspes folus* | • Predators such as green lacewings, minute pirate bugs and spiders feed on leafroller larvae.<br>• Use pheromone traps to monitor and trap adult moths.<br>• Sanitation: Control weeds in and around orchard. Disc under crop residues and weeds. | • Can use natural insecticides containing spinosad. |
| Thrips, *Panchaetothrips indicus* | • Monitor using blue sticky traps<br>• Crop monitoring for thrips<br>• Transplanting healthy plants.<br>• Destroy weeds and alternate host crops<br>• Sanitation: Clean plants and debris from previous crops. | • The following insecticides may control thrips: *Beauveria bassiana,* abamectin (use formulations below 1.9%), Neem extract, acetamiprid, imidacloprid (recommended for use during vegetative growth, not flowering), potash soap and spinosad, thiamethoxam (recommended for use during vegetative growth, not flowering), permethrin. |
| Leaf Spots, *Colletotrichum capsici* | • Use resistant varieties and transplant only healthy plants.<br>• Transplant trays with infected plants should be removed immediately from production sites.<br>• Workers should disinfest their hands after contact with infected plants. | • If needed, can use products containing azoxystrobin, chlorothalonil, trifloxystrobin, propiconazole and tebuconazole. |
| | **Brassicaceous: Turnips, Radish** | |
| Mustard aphid<br>*Lipaphis erysimi* | • Use of "habitat plantings" (flowering perennial plants that attract aphid parasites and predators.<br>• Carefully manage nitrogen levels so that they are neither too high (which significantly attracts aphids) or too low (which impedes plant growth).<br>• Natural enemies that can be attracted to fields with habitat plantings include aphid and syrphid flies, lacewings, and the predaceous midge, minute pirate bugs, big-eyed bugs, lady beetles, soldier beetles, and parasitic wasps like *Diaeretiella rapae*.<br>• In some humid areas there are outbreaks of naturally existing fungi that cause epidemics among aphid colonies.<br>• When plants are young and leaf cupping has not yet occurred, high pressure overhead sprinkler irrigation dislodges aphids.<br>• Inter-planting with clover (as a "living mulch") reduces aphid | • Organically accepted insecticides include those containing insecticidal soap, neem and pyrethrum.<br>• Use synthetic pesticides containing acephate, acetamiprid (recommended for use during vegetative growth, not flowering), spirotetramat, chlorpyrifos, or pymetrozine. |

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| | populations.<br>• Use trap crops: Plant mustards or collards on field margins or inter-planted and destroy these plants once heavily infested. | |
| Mustard saw fly (*Athalia lugens*) | • Several natural parasites and predators control sawflies.<br>• Use sawfly resistant cultivars.<br>• Use crop rotation.<br>• Delay planting of spring mustards.<br>• Sanitation: Use shallow fall tillage to destroy and burry crop stubble. | • Use natural pesticides containing BT.<br>• Use synthetic pesticides containing malathion. |
| Weeds | • Monitor and identify weed species present.<br>• Use fallow practices.<br>• Sanitation: To reduce seed production, disc or mow harvested fields before weeds flower and produce seeds. Cultivation equipment and irrigation water must also be kept free of weed seeds and vegetative propagates to avoid spreading weed populations. Cultivate areas around the field such as field edges, fence lines, roadsides, and irrigation ditches regularly to prevent weed seed production. To reduce seed production, disc or mow harvested fields before weeds flower and produce seeds.<br>• Preplant plowing, followed by irrigation and one or two discings before bed formation, will destroy many weeds.<br>• Proper bed preparation is important for successful weed cultivation after the crop is planted.<br>• Regularly clean farm tools.<br>• Use green manure which chokes out weeds.<br>• Use intercropping.<br>• Hand weeding during their earlier growing period. Do not let the weeds flower (do not compost weeds that have flowered and set seed).<br>• Hoeing, mowing, and cutting. | • During fallow, use synthetic herbicides containing glyphosate (use only acute toxicity Classes II and III products; not Class I).<br>• Pre-plant, before weeds emerge, use synthetic herbicides containing trifluralin. |
| **Umbelliferous: Coriander** | | |

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| Cotton Whitefly, *Bemisia tabaci* | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 white fly per 10 plants, spraying may be used.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray natural solutions of insecticidal soap, horticultural oil, neem oil or *Beauveria bassiana* if the infestation is heavy.<br>• Treat soil with synthetic systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) or thiamethoxam (recommended for use during vegetative growth, not flowering).<br>• Spray with synthetic insecticides containing acetamiprid (recommended for use during vegetative growth, not flowering). |
| Damping off disease, *Rhizoctonia* species | • Grow and plow under a mustard cover crop to biologically 'fumigate' the soil.<br>• Use certified clean seed.<br>• Monitor plants continuously for disease presence.<br>• Plant fields with coarse-textured soils first because they are less likely to become waterlogged and will warm up faster. | • Can use synthetic fungicides containing azoxystrobin, mancozeb or thiophanate methyl. |
| Blossom Blight, *Botrytis cinerea* | • Use resistant cultivars.<br>• Do not plant too thick; Maintain proper spacing and air flow around plants.<br>• Sanitation: Plowing or disking diseased plants and plant parts results in rapid decomposition of infected tissues. | • Can use pre-harvest fungicides containing copper or sulfur. |
| **Forage/Fodder Legumes: Alfalfa/Lucerne; Clovers/Sainfoin/Espartset/Berseem; Vetches; Trefoils** | | |
| Army worm<br>*Mythimna spp*<br><br>Lucerne caterpillar<br>*Spodoptera exigua* | • Caterpillar natural enemies (keep populations down) include predators like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae. Parasitic wasps of *Trichogramma* species, *Copidosoma* species, *Apanteles* species, *Diadegma* species, and *Hyposoter* species sting and parasitize eggs and larvae (some of these organisms are available commercially).<br>• Control weeds around field. | • Use of organic biopesticides or microbial controls consisting of *Bacillus thuringiensis*/BT Aizawai, the insect-eating fungus bacterial extracts like spinosad and living caterpillar viruses.<br>• Use of organic botanical insecticides like neem combined with diatomaceous earth. |

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| | • Use of organic herbal repellents like those extracted from garlic (Cropguard, Garlic Barrier), red chili peppers or neem oil.<br>• Use early cutting if armyworm infestation appears late in the growth cycle. | • Use of synthetic pesticides containing indoxacarb, spinetoram, chlorantraniliprole, methoxyfenozide. |
| Lucerne aphids<br>*Aphis spp*<br><br>Aphid<br>*Acrythosiphon pisum* | • Numerous significant aphid predators, diseases and parasites exist, including lady beetles, green lacewings, big-eyed bugs, damsel bugs and Syrphid fly larvae. Fungal diseases infect aphids and several tiny wasp species parasitize aphids.<br>• Use resistant varieties.<br>• Do field monitoring surveys and aphid identification<br>• Use "border strip cutting/harvesting[78]". | • Natural insecticides include azadirachtin, neem oil.<br>• Use of synthetic Insecticides containing dimethoate. |
| Lucerne weevil<br>*Sitona discoideus* | • A fungal disease infects weevils and several tiny wasp species parasitize weevil larvae.<br>• After weevil larvae are present, monitor every 2-4 days.<br>• Use early cutting of the plant at the bud stage if weevil damage seems imminent.<br>• Closely monitor alfalfa re-growth for the second cutting to detect feeding damage. | • Use synthetic insecticides containing indoxacarb, lambda cyhalothrin (use formulations 10% and below), or malathion. |
| Fusarium seedling wilt (*Fusarium oxysporum*) | • Use resistant cultivars. | • Fungicides are not recommended. |
| Rhizoctonia crown and stem rot (*Rhizoctonia solani* and other fungi) | • Plant early, when temperatures are too low for disease development.<br>• No other controls are known. | • Fungicides are not recommended. |
| Berseem Clover root rots, *Rhizoctonia solani, Fusarium semitactatum, Tylenchorhynchus vulgaris* | • Use resistant cultivars.<br>• Plant early, when temperatures are too low for disease development.<br>• Use well-drained soil. | • Fungicides are not recommended. |
| Sclerotinia crown and stem rot/white mold; Berseem | • Deep plowing of fields will prevent germination of most sclerotia<br>• Early February plantings may escape the disease. | • Fungicides are not recommended. |

[78] http://www.ipm.ucdavis.edu/PMG/r1900411.html

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| Stem Rot, (*Sclerotinia trifoliorum*) | • Sanitation: Remove as much foliage as possible before winter by mowing or grazing.<br>• Control weeds (alternate Sclerotinia hosts) in adjacent fields and field margins.<br>• Do good weed control in the field to open the canopy to air and sun. | |
| Weeds, several species including Dodder | • Monitor for weed seedlings following alfalfa cutting, and correctly identify them.<br>• Irrigate field shortly before harvest (so alfalfa can quickly re-grow before weeds).<br>• Delayed irrigation after harvest.<br>• Do fast and complete fall or winter grazing.<br>• Interplant grasses or legumes: Plant oats, clovers or other annual or perennial plants into declining forage stand to increase yield and decrease weeds. | • Pre-plant, use synthetic herbicides containing metribuzin, pendimethalin, trifluralin.<br>• After weeds emerge, use synthetic herbicides containing clethodim. |
| **Stone Fruits/Drupes: Apricot; Peach; Almond; Plum; Cherry** | | |
| Aphids:<br>Black peach aphid<br>*Pteroclorus persica*<br>Green peach aphid<br>*Myzus persicae*<br>Peach curl aphid<br>*Anuraphis belichyrysi*<br>Apricot aphid, *Aphis arundinis* | • Use resistant varieties<br>• Use regular monitoring with yellow sticky traps<br>• Many types of natural enemies and pathogens may control these aphids under low insecticide input situations. However, these aphids reproduce quickly and move into protected areas of the plants, thereby greatly reducing the potential impact of their predators and parasitoids in older stage plants.<br>• Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• If control is needed, treat when aphids are found to be reproducing, particularly when second and later generation wingless females have started reproduction. Aphid populations are easier to control before the plants begin to cup. | • Can use insecticides available for post-emergence foliar treatments. Contact insecticides have limited impact as plants enter the cupping stage.<br>• Can use natural insecticide containing neem oil/azadirachtin or paraffin oil.<br>• Can use systemic synthetic insecticides s containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or pymetrozine.<br>• Can spray with synthetic insecticides containing thiamethoxam (recommended for use during vegetative growth, not flowering). |
| Scale | • Scale-eating insect species in the following genera are promoted | • Avoid over-spraying other pests, which may kill natural enemies of scales. |

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| *Parlatoria oleae* | and generally provide sufficient control: Coccophagus, Encyrtus wasps, and Metaphycus. | • Use natural applications of lime or dormant season paraffin oils. |
| Fruit flies<br>*Bactrocera dorsalis;*<br>*Dacus spp* | • If needed, purchase and introduce parasitoids to the orchard.<br>• Baited (with methyl eugenol) traps can be used to monitor the presence and control the flies.<br>• Fruit fly adults feed on honeydew. Reducing black scale populations may reduce a food source needed during high summer temperatures.<br>• Sanitation: Collect and burry all dropped fruits. | • The use of sprays/dusts of kaolin clay or diatomaceous earth and baited (GF-120 Fruit Fly Bait) traps are acceptable for use in an organically certified crop. |
| Red Plum Maggot,<br>*Cydia funebrana* | • Sanitation: Remove infested & dropped apples, oil spray on apples when females fly.<br>• Mass trapping and mating disruption using pheromone traps.<br>• Pruning tree for height and spraying efficacy.<br>• Remove host trees in nearby abandoned orchards (apple, pear, and walnut) to destroy reservoirs of moth.<br>• Remove props, picking bins, and fruit piles from the orchard. | • Use natural sprays of spinosad, narrow range oil and kaolin clay.<br>• Use synthetic insecticides containing spinetoram, acetamid, and thiacloprid (recommended for use during vegetative growth, not flowering). |
| Wasps, *Vespa* species | • Locate and control wasp nests. | • No chemicals are recommended. |
| Buprestid borer<br>*Sphenoptera lafertei* | • Paint tree trunks white to prevent sunburn, which predisposes tree to attack.<br>• Provide sufficient water, fertilizer, and pruning.<br>• Prune away heavily infested tree parts.<br>• Remove heavily infested trees. | • Insecticides are not recommended. |
| Apricot seed chalcid<br>*Eurytoma samsonovi* | • Examine nuts for small holes that indicate a seed chalcid has emerged from the nut.<br>• Adults can also be monitored by the use of yellow sticky traps.<br>• Sanitation: remove and destroy nuts left on the tree following harvest as well as those that have fallen on the ground. | • Insecticides are not recommended. |
| Almond bark beetle<br>*Scolytus amygdali* | • Maintain trees in vigorous and undamaged condition.<br>• Use sufficient fertilizers and water (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Sanitation: do pruning to remove and burn heavily infested tree parts and remove old heavily-infested trees. | • Spraying with insecticides is not recommended. |

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| | • Do not store cut branches or trees near field; burn them. | |
| Tip borer, *Quettania coeruleipennis*<br>Cherry Borer, *Aeolesthes holosericea* | • Several species of natural enemies including Chalcid wasps and ants exist that exert control.<br>• To monitor, use peach twig borer pheromone traps.<br>• Use pheromone release for mating disruption. | • Use of insecticides containing spinosad or BT sprayed at bloom, preceded by delayed dormant paraffin oil to control scale and mite eggs.<br>• At full bloom use diflubenzuron (use formulations less than 25%, most formulations below 25% are GUP, and above 25% are RUP), spinetorum, methoxyfenozide. |
| Muskmelon fly<br>*Myiopardalis pardalina* | • Ants are natural enemies of melon fly.<br>• Keep field weed free.<br>• Use recommended plant spacings, do not plant seeds too close.<br>• Winter suppression: Till area under infested melons to kill pupae.<br>• Sanitation: Destroy infested melons before larvae emerge. | • Few pesticide methods are available for control.<br>• Synthetic insecticides containing carbaryl or deltamethrin may be spot-applied on places where infested melons rested, larvae entered the soil, and where adults will emerge. |
| Hairy caterpillar<br>*Euproctis spp* | • Many parasitic wasps and flies attack the larvae. | • Can use insecticides containing natural *Bacillus thuringiensis* (BT, subspecies Kurstaki) or insect growth regulator diflubenzuron (use formulations less than 25%, most formulations below 25% are GUP, and above 25% are RUP).<br>• Can use synthetic insecticides containing indoxacarb. |
| Mites:<br>Red spider mites, *Tetranychus telarius*<br>Blister mite, *Eriophyes pyri*<br>European Red mite, *Panonychus ulmi* | • Use resistant varieties.<br>• The western predatory mite, six spotted thrips and are spider mite destroyer are excellent predators of orchard mites.<br>• Properly irrigate trees and reduce orchard dust. Grass cover crops and sprinkler irrigation minimize dust in orchards. Do not mow the cover crop too short or let it dry or the mites may move up into the trees. | • Monitoring & timing of use of natural dormant paraffin oil sprays.<br>• Use of synthetic insecticides containing pyridaben, hexythiazox, fenpyroximate or dicofol. |
| Leaf rust,<br>*Tranzschelia pruni-spinosae var* | • Use drip irrigation.<br>• Prune to open canopy to air flow and light. | • Can use natural fungicides containing sulfur.<br>• Can use synthetic fungicides containing |

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| *discolor* | | tebuconazole, propiconazole, azoxystrobin or trifloxystrobin. |
| Leaf curl and Plum Pocket, *Taphrina deformans, Tephrina fungi* | • Sanitation: Pruning and destruction of diseased parts. | • Can use Bordeaux mixture, chlorothalonil, and fixed copper. |
| Bacterial cankers and spots, *Pseudomonas syringae, Xanthomonas pruni* | • Use of certified disease-free propagation material and treated seed.<br>• Do weed control.<br>• Use resistant or tolerant varieties.<br>• Plant in well-drained soils.<br>• Avoid over-irrigation.<br>• Use deep well water for irrigation.<br>• Remove and destroy diseased plants. | • Spray with copper-containing compounds. |
| Brown spot *Monilinia fructicola* | • Sanitation: Remove from orchard and destroy diseased fruits and fruit mummies. | • Use pre-harvest treatment with synthetic fungicides containing propiconazole, fenbuconazole, pyraclostrobin, thiophanate-methyl, myclobutanil.<br>• Can use post-harvest treatment with fludioxonil. |
| Peach scab *Cladosporium carpophilum* | • In fields with a history of scab, apply protective fungicides within 3 weeks after full bloom. | • Use fungicides containing copper, azoxystrobin, trifloxystrobin, pyraclostrobin, chlorothalonil, and thiophanate-methyl. |
| Shot hole *Stigmina carpophila* | • Maintain a vigorous plant by properly watering and fertilizing following soil test results.<br>• Sanitation: Prune out dead plant material and material with lesions and dead buds; Removal and destruction of infected fruits and leaves. | • Use a natural Bordeaux mix or fixed copper.<br>• At red bud, full bloom and petal fall, use a synthetic fungicide containing pyroclostrobin, chlorothalonil, trifloxystrobin, azoxystrobin. |
| Powdery mildew *Sphaerotheca pannosa* | • Avoid growing almonds near apple varieties that are highly susceptible to powdery mildew, such as Jonathan, Gravenstein, and Rome Beauty. If nearby apples are expected to cause mildew problems on almonds, control the disease on apples.<br>• Jacket-split (late petal fall) and mid-spring applications of powdery mildew fungicides are highly effective in managing the disease. | • Sulfur sprays (wettable sulfur, liquid lime sulfur and sulfur dusts) can be used, as can fungicides containing myclobutanil. |

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| Root rots<br>*Phytophthora cactorum*<br>*Rosellinia necatrix*<br>*Corticium rolfsii* | • Avoid soil saturation of water that exceeds 24 hours.<br>• Ensure good soil drainage, drain low spots in orchard.<br>• Practice planting new trees on small mounds, berms or ridges of 20-25 cms in height (which can drain well).<br>• Some plum rootstocks for grafting contain resistance to Phytopthora.<br>• Planting soil depth should be no deeper than nursery soil depth.<br>• Graft unions should be well above the soil level. | • If needed, use fungicides containing fosetyl-aluminum, mefenoxam or phosphorous acid. |
| Cherry Crown Gall Disease, Agrobacterium tumefasciens | • Heat treat planting stock with hot water at recommended temperatures.<br>• Avoid plant injuries.<br>• Use good sanitation:<br>• Remove grow tubes on over-wintering vines. | • Chemical treatments are not generally effective. |
| Cherry Tree Nematode, Tylenchus pakistanensis | • Use certified clean planting material.<br>• Use of organic fertilizer particularly chicken manure and composts to add organic matter and soil structure to sandy soils<br>• Growing flax, a tropical herb, is good for controlling root knot nematodes.<br>• African and French marigold (*Tagetes minuta* and *T. patula,* respectively) attract and can be used to trap nematodes. But, 2 months after planting, marigolds must be dug up with roots, and destroyed, or they will serve as a source of inoculation. | • Management of nematodes is difficult, especially in sandy soils.<br>• Botanical and homemade water extracts of basil, garlic and neem seed may be effective controls.<br>• Two new commercialized products, once registered for use, can be used as effective nematode controls: the microbe *Myrothecium verrucaria* and natural soil biopesticide labeled as Promax (containing extracts of tomatillo oil and thyme oil) |
| **Pome Fruits: Apple; Pear; Loquat; Quince** | | |
| Aphids:<br>Black peach aphid<br>*Pteroclorus persica*<br>Green peach aphid<br>*Myzus persicae*<br>Peach curl aphid<br>*Anuraphis belichyrysi* | • Use resistant varieties<br>• Use regular monitoring with yellow sticky traps<br>• Many types of natural enemies and pathogens may control these aphids under low insecticide input situations. However, these aphids reproduce quickly and move into protected areas of the plants, thereby greatly reducing the potential impact of their predators and parasitoids in older stage plants.<br>• Field disking and destruction of crop residues are important for | • Can use insecticides available for post-emergence foliar treatments. Contact insecticides have limited impact as plants enter the cupping stage.<br>• Can use natural insecticide containing neem oil/azadirachtin or paraffin oil.<br>• Can use systemic synthetic insecticides containing imidacloprid (recommended for use during vegetative growth, not |

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| Others: *Aphis spiraecola* *Brachycaudus helichrysi* | control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• If control is needed, treat when aphids are found to be reproducing, particularly when second and later generation wingless females have started reproduction. Aphid populations are easier to control before the plants begin to cup. | flowering), acetamiprid (recommended for use during vegetative growth, not flowering) or pymetrozine, thiamethoxam (recommended for use during vegetative growth, not flowering). |
| Pear psylla *Cacopsylla bidens* | • Natural enemies that control aphids include green and brown lacewings, lady beetles, Syrphid fly larvae.<br>• Monitor, predict, and manage populations to low levels. | • Use natural sprays of heavy mineral oil mixed with lime sulfur/Bordeaux mix or insecticidal soaps.<br>• Can use synthetic insecticides containing chlorpyrifos or dimethoate.<br>• Delayed dormant application of narrow range paraffin oils containing pyriproxyfen or esfenvalerate. |
| Scales:<br>Olive scale<br>*Parlatoria oleae*<br>San Jose scale<br>*Quadraspidiotus perniciosus* | • Natural parasitoids and pruning normally keep pest populations at tolerable levels.<br>• For monitoring flying adult male scales, use pheromone traps.<br>• For monitoring crawlers, use sticky traps.<br>• Maintain tree vigor: Ensure that plants do not become water-stressed; irrigate and fertilize properly.<br>• Manage and reduce dust levels in orchard.<br>• Control ant populations in orchard.<br>• Remove plants or plant parts that are repeatedly heavily infested.<br>• Prune lower branches and do weed control (limits ant access to scales). | • Do not use broad-spectrum insecticides.<br>• Use natural applications of lime or dormant narrow range paraffin oils during dormant season.<br>• Use “ant stakes” (baited mixes of ant-attractant with insecticides) to control ants.<br>• Can use systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) applied to soil. |
| Fruit fly<br>*Dacus spp* | • If needed, purchase and introduce parasitoids to the orchard.<br>• Baited (with methyl eugenol) traps can be used to monitor the presence and control the flies.<br>• Fruit fly adults feed on honeydew. Reducing black scale populations may reduce a food source needed during high summer temperatures.<br>• Sanitation: Collect and burry all dropped fruits. | • The use of sprays/dusts of kaolin clay or diatomaceous earth and baited (GF-120 Fruit Fly Bait) traps are acceptable for use in an organically certified crop. |
| Stem and Trunk Borers:<br>Buprestid borer | • Paint tree trunks white to prevent sun burn, which predisposes tree to attack.<br>• Provide sufficient water, fertilizer, and pruning. | • Insecticides are not recommended. |

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| *Sphenoptera lafertei*<br>Apple Stem Borer, *Aeolestbes sarta* | • Prune away heavily infested tree parts.<br>• Remove heavily infested trees. | |
| Apple codling moth<br>*Cydia pomonella* | • Sanitation: Remove infested & dropped apples, oil spray on apples when females fly,<br>• Mass trapping and mating disruption using pheromone traps.<br>• Pruning tree for height and spraying efficacy.<br>• Remove host trees in nearby abandoned orchards (apple, pear, and walnut) to destroy reservoirs of codling moth.<br>• Remove props, picking bins, and fruit piles from the orchard. | • Can use synthetic insecticides containing lufenuron. |
| Apple wooly aphid<br>*Eriosoma lanigerum* | • Use resistant varieties/rootstocks.<br>• Natural enemies that control aphids include a parasitic wasp, green and brown lacewings, lady beetles, Syrphid fly larvae. | • Use biological controls and sprays of insecticidal soap, delayed dormant applications of narrow range paraffin oils and azadirachtin.<br>• Can also use synthetic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering). |
| Western tent caterpillar (*Malacosoma indica* | • Monitor in spring and early summer to identify trees with small nests.<br>• Hand collection and destruction of the nests. | • If needed, use localized or spot treatments containing natural *Bacillus thuringiensis* (BT, subspecies Kurstaki). |
| Mites<br>*Cenopalpus pulcher* | • Use resistant varieties.<br>• The western predatory mite, six spotted thrips and are spider mite destroyer are excellent predators of orchard mites.<br>• Properly irrigate trees and reduce orchard dust. Grass cover crops and sprinkler irrigation minimize dust in orchards. Do not mow the cover crop too short or let it dry or the mites may move up into the trees. | • Monitoring & timing of use of natural dormant paraffin oil sprays.<br>• Use of synthetic insecticides containing pyridaben, hexythiazox, fenpyroximate or dicofol. |
| Azalea/apple lace bug<br>*Stephanitis pyrioides* | • Maintaining healthy plants with proper watering and fertilizer treatments reduces plant stress as well as damage potential.<br>• A hard jet of water from a garden hose could be directed on the undersides of the foliage to dislodge the bugs and possibly kill the nymphs, but any remaining live lace bugs may still damage the | • Insecticidal soap, paraffin oil, neem oil and most synthetic insecticides provide good control. It is important to direct the spray to undersides of the leaves for optimal coverage. |

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| | foliage. | |
| Ripe/soft rot<br>*Rhizopus arrhizus* | • Reduce injury and damage to fruit.<br>• Use proper irrigation and fertilization for optimal tree health. | • No synthetic fungicides recommended. |
| Powdery mildew (*Podosphaera leucotricha*) | • Sanitation: Prune away and destroy infected shoots during dormancy or early spring. | • Treatments with sulfur alone, natural lime and sulfur, or with fixed copper products.<br>• Can use synthetic fungicides containing fenarimol, myclobutanil, triflumizole, trifloxystrobin, triadimefon, thiophanate methyl. |
| Sooty blotch and fly speck<br>*Gloeodes pomigena*<br>*Schizothyrium pomi*<br>*Microthyriella rubi* | • Removing reservoir hosts, especially brambles, from the orchard and surrounding hedgerows helps reduce the amount of inoculum from external sources, but in wet years this practice alone may not be adequate for disease control.<br>• Dormant and summer pruning to open up the tree canopy and thinning to separate fruit clusters.<br>• Both diseases are difficult to control in orchards with restricted air movement. | • Can use natural lime-sulfur. |
| Apple scab (*Venturia inaequalis*) | • Prevent or reduce primary infections in spring.<br>• Use a fall foliar fertilizer application of zinc sulfate and urea to hasten leaf fall and speed decomposition of fallen leaves (reduces the level of overwintering apple scab inoculum). | • Can use synthetic fungicides containing fenarimol, myclobutanil, triflumizole, trifloxystrobin, pyrimethanil, kresoxim-methyl (likely carcinogen, PPE essential with repeated use), thiophanate methyl, mancozeb. |
| Fire blight (*Erwinia amylovora*) | • Use resistant varieties/rootstocks.<br>• Avoid over-application of nitrogen fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Avoid over-pruning.<br>• Avoid over-irrigation.<br>• Sanitation: Cut out and destroy infected tissues and diseased wood.<br>• If available, degree-day models can be used to time application of antibiotics in the spring. | • Use natural applications of Bordeaux mix, or blossom application of fixed copper or streptomycin sulfate antibiotics. |

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| Root rots<br>*Phytophthora cactorum*<br>White root rot<br>*Rosellinia necatrix* | • Avoid soil saturation of water that exceeds 24 hours.<br>• Ensure good soil drainage, drain low spots in orchard.<br>• Practice planting new trees on small mounds, berms or ridges of 20-25 cms in height (which can drain well).<br>• Some plum rootstocks for grafting contain resistance to Phytopthora.<br>• Planting soil depth should be no deeper than nursery soil depth.<br>• Graft unions should be well above the soil level. | • If needed, use fungicides containing fosetyl-aluminum, mefenoxam or phosphorous acid. |
| | **Pomegranate** | |
| Butterfly<br>*Virachola isocrates* | • Sanitation: Collect and destroy all infested fruits.<br>• Cover immature fruits with a bag or cloth. | • Can use natural insecticides containing neem oil/azadirachtin.<br>• Can use sprays of synthetic insecticides containing carbaryl, deltamethrin or malathion. |
| Hairy caterpillar, *Euproctis fraterna* | • Use resistant varieties.<br>• Handpick larvae.<br>• Natural enemies like ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big-eyed bugs, and lacewing larvae naturally control armyworms. Parasitic wasp species *Trichogramma*, *Copidosoma*, *Apanteles*, *Diadegma*, and *Hyposoter* sting and parasitize eggs and larvae (some of these organisms are available for purchase commercially).<br>• Use of nocturnal overhead sprinkler irrigation to dislodge and repel pests.<br>• Use of floating row screen or mesh covers to exclude egg-laying moths. | • If needed, use pesticides containing neem, or spinosad.<br>• Use of artisanal or commercial extracts of garlic or chili pepper, neem.<br>• Use of synthetic pesticides containing indoxacarb, chlorantraniliprole. |
| Fruit fly,<br>*Dacus ferrugineus* | • If needed, purchase and introduce parasitoids to the orchard.<br>• Baited (with methyl eugenol) traps can be used to monitor the presence and control the flies.<br>• Fruit fly adults feed on honeydew. Reducing black scale populations may reduce a food source needed during high summer temperatures.<br>• Sanitation: Collect and burry all dropped fruits. | • The use of sprays/dusts of kaolin clay or diatomaceous earth and baited (GF-120 Fruit Fly Bait) traps are acceptable for use in an organically certified crop. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| Pomegranate Mites:<br>*Tenuipalpus lustrabilis*<br>*Tenuipalpus hornotinus* | • Control weeds in orchard.<br>• Control mites by providing trees with adequate water. | • To control the mites, use miticides with neem, abamectin (use formulations below 1.9%) and paraffin oil, fenpyroximate, or fenpropathrin. |
| Fruit rot<br>*Zythia versoniana* | • Sanitation: Collect and destroy heavily infested fruits. | • Use of fungicides containing copper applied late afternoon. |
| | **Mango** | |
| Mango hoppers,<br>*Idioscopus clypealis*<br>*Amritodus atkinsoni* | • Avoid water-logging and damp conditions.<br>• Prune trees to open up canopy.<br>• Plant trees the optimum distance apart. | • Can use insecticides containing dimethoate and copper oxychloride. |
| Giant mango mealy bug,<br>*Drosicha stebbingi* | • Use the funnel-type slippery traps installed around mango trunks or sticky bands to trap and remove mealy bugs from orchard. | • Can use insecticides containing acetamiprid (recommended for use during vegetative growth, not flowering). |
| Mango fruit fly<br>*Dacus dorsalis* | • If needed, purchase and introduce parasitoids to the orchard.<br>• Baited (with methyl eugenol) traps can be used to monitor the presence and control the flies.<br>• Fruit fly adults feed on honeydew. Reducing black scale populations may reduce a food source needed during high summer temperatures.<br>• Sanitation: Collect and burry all dropped fruits. | • The use of sprays/dusts of kaolin clay or diatomaceous earth and baited (GF-120 Fruit Fly Bait) traps are acceptable for use in an organically certified crop. |
| Mango stem borer<br>*Batocera rufumaculata* | • Mechanical removal of grubs from stem.<br>• Removal and destruction of affected branches. | • No insecticides are recommended. |
| Mango bud mite<br>*Aceria mangifera* | • Control mites by providing trees with adequate water. | • Can use miticides with neem, abamectin (use formulations below 1.9%) and paraffin oil, fenpyroximate, or fenpropathrin. |
| Mango scale<br>*Phenacaspis cockerelli* | • Natural enemies such as parasitic wasps control scales in the orchard.<br>• Eliminate other host plants on or near the plantation.<br>• Cut back on shade by pruning. | • Use of dormant paraffin oil, neem oil. |
| Anthracnosis *Colletotrichum gloeosporioides,* | • Maintain a clean plantation.<br>• Sanitation: Removal and destruction of fallen and leftover mangoes | • Can use copper-containing fungicides during flowering. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| *Glomerella cingulata* | and fallen leaves.<br>• Pruning to promote ventilation of crown. | • For other times, management can be done with fungicides containing triadimenol, cyproconazole, copper sulfate and mancozeb. |
| Root rots<br>*Rhizoctonia solani*<br>*Fusarium oxysporum* | • Plant mango in sandy soil or increase soil content of soil.<br>• Sanitation: Remove and burn diseased or dead trees.<br>• Do not plant on land that had root rot issues. | • No fungicides are recommended. |
| Mango dieback (*Lasiodiplodia theobromae*) | • Maintain a clean plantation.<br>• Apply agricultural calcium to soil.<br>• Sanitation: Pruning trees to open up canopy. Cleaning up and destroying dead branches. | • Paint tree trunks with copper sulfate. |
| Sooty molds<br>*Tripospermum acerinum*<br>*Capnodium mangiferae*<br>*Meliola mangiferae* | • Keep ants out of orchard.<br>• Sanitation: Pruning trees to open up canopy. Cleaning up and destroying fallen fruit and mummies.<br>• Control weeds in orchard. | • Control mealy bugs and ants by using insecticides containing acetamiprid (recommended for use during vegetative growth, not flowering). |
| Malformation of inflorescence by a combination of mites and *Fusarium mangiferae* | • Control weeds in orchard.<br>• Control mites by providing trees with adequate water. | • To control the mites, use miticides with neem, abamectin (use formulations below 1.9%) and paraffin oil, fenpyroximate, or fenpropathrin. |
| Mango Powdery mildew (*Oídium mangiferae*) | • Maintain a clean plantation. | • Can use elemental sulfur for control.<br>• Can use copper-containing fungicides during flowering. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Mango Quick Decline caused by Diplodia dry and wet stem rot (*Botryodiplodia theobromae*) | • Promote good cultural practices to enhance tree vigor and reduce the amount of dead wood.<br>• Harvesting by pulling rather than clipping can reduce the incidence of decay, because it removes at least some of the buttons, which harbor the pathogen.<br>• Immediate cooling after packing effectively delays development of stem end rot; the decay is almost completely inhibited at 10°C. | • Can use synthetic fungicides containing difenoconazole applied to the trunk.<br>• Postharvest application of imazalil fungicide provides good control of Diplodia stem-end rot. Treatments can be applied before degreening by drenching pallets of harvested fruit with fungicide suspensions or solutions. |
| Ceratosistis Quick Decline (*Ceratocystis fimbriata*) | • Use healthy, undamaged disease-free and resistant hybrid planting materials.<br>• Disinfect stems prior to planting.<br>• Maintain good soil drainage and reduce soil humidity. | • To disinfect seedlings, fungicides containing fosetyl aluminum and metalaxyl can be used. |
| **Citrus** | | |
| Citrus leaf miner<br>*Phyllocinistis citrella* | • In older orchards, controlled by several species of wasp parasites.<br>• Avoid pruning live branches more than one time a year, to reduce new leaf flushes.<br>• Do not apply large amounts of nitrogen while miners are present.<br>• Remove 'water sprouts' (vigorous shoots that grow above graft unions) and 'suckers' (grow below graft unions).<br>• Sanitation: remove crop debris and weeds.<br>• Do crop monitoring for detection and control decisions.<br>• Use pheromone traps for monitoring and mass trapping. | • Can spray trees with narrow range paraffin oils and natural insecticide containing neem oil/azadirachtin to kill eggs laid on leaves. |
| Citrus psylla<br>*Diaphorina citri*<br>Can transmit Huang Long Bing (HLB) bacteria | • Several natural predators feed on and control the citrus psylla.<br>• Use and plant only certified clean tree stock.<br>• Place imported and diseased tree stock under quarantine.<br>• Sanitation: Remove and destroy infested and infected trees. | • Insecticides containing synthetic pyrethroids like deltamethrin, esfenvalerate or lambda cyhalothrin (use formulations 10% and below), beta cyfluthrin (use formulations 10% and below) or bifenthrin (use only 10% EC and 2.5% ULV formulations). |
| Lemon/lime swallowtail butterfly, *Papilio demoleus* | • Handpick larvae on smaller orchards.<br>• Use pheromone traps. | • Use natural insecticides containing neem, fatty acid soaps, or BT.<br>• Use insecticides containing synthetic pyrethroids like deltamethrin, esfenvalerate or lambda cyhalothrin (use |

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| | | formulations 10% and below), beta cyfluthrin (use formulations 10% and below) or bifenthrin (use only 10% EC and 2.5% ULV formulations). |
| Cloudy winged white fly, *Aleurolobus citrifolii* | • Controlled in nature by hymenopteran parasitoids (*Encarsia* species), lady beetles and minute pirate bugs.<br>• Monitoring crops and establishment of a pesticide program after finding 1 WF per 10 plants.<br>• Yellow sticky traps may reduce populations but cannot prevent the spread. | • Spray solution of insecticidal soap and/or paraffin oil if infestation is heavy.<br>• Use of synthetic insecticides containing azadirachtin or neem oil. |
| Citrus Black Aphid, *Aphis citricidus* | • A number of coccinellid and syrphid predators, parasites and fungal diseases usually keep aphid populations below damaging levels.<br>• Maintain adequate soil moisture and fertilization (Plants stressed for water or nutrients are more susceptible to and suffer greater damage from aphids).<br>• Use regular monitoring, yellow sticky traps.<br>• Sanitation: Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• Avoid early planting.<br>• Avoid excessively high soil nitrogen levels. | • Treatments with natural chemicals, if needed, can include narrow range oils, pyrethrin.<br>• No synthetic pesticides are recommended for spraying. |
| Citrus red scale, *Aonidiella aurantii* | • Many predators and parasites control scales, including beetles, bugs, green lacewings and predatory mites.<br>• Monitor for presence of scales and in the summer, crawlers.<br>• Provide plants with good growing conditions and especially appropriate irrigation.<br>• Prune branches to open them up to light, sun and predators.<br>• Sanitation: Prune off and destroy heavily infested branches.<br>• Manage ants that tend the scales by placing tanglefoot around the tree trunk. | • Use natural dormant or summer paraffin oil and insecticidal soap to kill crawlers (larval stage). |
| Citrus mealy bug, *Pseudococcus citri* | • Natural parasitic wasps and predators such as lady beetle adults and larvae, lacewings adults and larvae, minute pirate bugs and spiders can control mealy bugs.<br>• Do regular monitoring, note taking and mapping of mealy bug | • In the summer, treatments can include insecticides containing dimethoate or buprofezin. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | infestations.<br>• Control honeydew-seeking ants using tillage and common vetch cover crops.<br>• Peel back the thin bark on spurs in the current season's prunings and look for the presence of mealy bug crawlers (larvae); if 20% of samples show crawlers apply a delayed dormant insecticide. | |
| Fruit Flies, *Dacus species* | • Use resistant grafted planting materials.<br>• Removal of fruit as it matures.<br>• Sanitation: Pruning trees to open up canopy. Cleaning up and destroying dropped infested citrus. | • Use of spinosad combined with liquid attractant as bait sprays on single trees nor lines and mass trapping with 1 trap/ha. |
| Citrus Slow Decline Disease, caused by nematode, *Tylenchulus semipenetrans* | • Exclude nematodes by using certified nematode-free nursery citrus stock.<br>• Exclude nematodes by using only certified nematode-free soil<br>• Prevent injury by using resistant varieties. | • Available nematicides are heavily restricted internationally and too toxic for untrained and unaware smallholders to use. |
| Withertip/Anthracnose (*Colletotrichum gloeosporioides*) | • Infects weakened twigs, so maintain tree vigor.<br>• Sanitation: Prune and remove and destroy deadwood.<br>• Immediate storage of packed fruit at temperatures below 40°F will help suppress development of anthracnose. | • Spray natural Bordeaux mix or a synthetic fungicide containing azoxystrobin. |
| Root rots/wilt/foot rot:<br>Phytophthora gummosis (*Phytophthora citrophthora* and *P. parasitica*);<br>Fusarium (*Fusarium spp*);<br>Rhizoctonia (*Rhizoctonia spp)* | • Use resistant or tolerant root stock.<br>• Plant trees on a berm or high enough so that the first lateral roots are just covered with soil.<br>• Use proper irrigation management and soil drainage.<br>• Remove the dark, diseased bark and a buffer strip of healthy, light brown to greenish bark around the margins of the infection. | • Copper treatments are acceptable for use on organically certified citrus.<br>• Use root dips or drench using natural fungicides containing *Trichoderma harzianum*. |
| Sooty mold (*Capnodium Citri*) that grows on sticky sweet defecate of aphids, scales and mealy bugs | • Control aphids, scales and mealy bugs, see above recommendations. | • See recommendations above. |
| Pink disease (*Cortisium salmonicolor*) | • Sanitation: Remove affected bark of the trunk and prune off diseased limbs.<br>• Sterilize tools between cuts and trees. | • Can use application of Bordeaux mix several times a year. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Greasy spot<br>*Mycosphaerella citri* spread by mites | • Control mites which spread this disease in the fall.<br>• Sanitation: remove and destroy leaf litter. | • Can use petroleum oil sprays or copper mid-May to June.<br>• Can use fungicides containing azoxystrobin + difenoconazole, trifloxystrobin.<br>• To control mites, use miticides with neem, abamectin (use formulations below 1.9%) and paraffin oil, fenpyroximate, or fenpropathrin. |
| Citrus Tristeza Virus (CTV) transmitted by aphids | • Use tolerant rootstocks and certified disease-free planting materials.<br>• Control aphid vectors (see aphids, above).<br>• Remove and destroy dead trees when they become unproductive. | • To control aphid vectors, may use natural insecticide sprays containing neem. |
| Citrus canker: (*Xanthomonas citri* subspecies *citri)* | • Use resistant varieties.<br>• Do not move equipment or personnel from infected orchards of groves to uninfected orchards; disinfect all tools and clothes.<br>• Remove and burn trees on-site.<br>• Control leaf miners. | • Use copper-containing pesticides. |
| Post-harvest green mold/blue mold Penicillium fruit rots (*Penicillium digitatum, P. italicum*) | • Sanitation: Remove and destroy molded fruit from orchard after harvest.<br>• Use careful harvesting and handling to avoid injury to fruit.<br>• Promptly eliminate molded fruit and green spores from pack house/storage.<br>• Use exhaust fans at storage house dumper to remove air and spores.<br>• Decayed fruit should never be re-packed within the packinghouse.<br>• The pallets, packinghouse, and packing line, including the washer brushes, should be sanitized daily to eradicate inoculum.<br>• Aqueous solutions in drenchers and soak tanks should be treated continuously with a sanitizer, such as chlorine. | • Preharvest fungicide treatments are usually ineffective. |
| | **Grapes** | |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| Grapevine leafhopper<br>*Erythroneura spp* | • Most grapevines can tolerate high levels of leafhopper damage.<br>• Many natural predators and parasitoids control leafhoppers.<br>• Remove basal leaves or lateral shoots during berry set and the 2-week period following.<br>• Do weed control in and around orchard. | • Use insecticides containing narrow range paraffin oils, insecticidal soaps, or kaolin clay.<br>• Use synthetic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering), acetamiprid (recommended for use during vegetative growth, not flowering), buprofezin, or dimethoate. |
| Grapevine thrips<br>*Rhipiphorothrips cruentatus* | • Some predators like minute pirate bugs control thrips.<br>• Avoid mowing cover crops at bud-break and before bloom. | • Use insecticides containing spinosad, dimethoate, imidacloprid (recommended for use during vegetative growth, not flowering) or paraffin oil. |
| Red Spider Mites,<br>*Tetranychus telaruis* | • Crop monitoring<br>• Plant away the other mite host plants.<br>• Destroy weeds and host crops as soon as possible, including the head rows.<br>• Always monitor before treatment with miticides. | • Can use natural miticides containing soap, paraffin oil, neem or spinosad (applied with good coverage to leaf undersides).<br>• Can use synthetic miticides containing abamectin (use formulations below 1.9%). |
| Grape leaf roller<br>*Sylepta lunalis* | • Predators such as green lacewings, minute pirate bugs and spiders feed on grape leafroller larvae.<br>• Use pheromone traps to monitor and trap adult moths.<br>• Sanitation: Control weeds in and around orchard. Disc under grape mummy clusters and weeds. | • Can use natural insecticides containing *Bacillus thuringiensis (BT)* Kurtaski and the Entrust formulation of spinosad.<br>• For the first generation, use synthetic insecticides containing methoxyfenozide.<br>• For second and third generations, use synthetic insecticides containing methoxyfenozide, spinosad and *Bacillus thuringiensis* Kurtaski (BT). |
| Grapevine beetle<br>*Sinoxylon anale* | • Natural parasitic wasps can control grapevine beetles.<br>• Remove all brush piles and refuse from orchard.<br>• Sanitation: Remove and destroy all pruned vines.<br>• Some formulations of nematodes (*Steinernema carpocasae)* control these beetles. | • Use synthetic insecticides containing carbaryl. |
| Grapevine girdler | • Hand-pick adults at night and near lights. | • Use synthetic insecticides containing |

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| *Sthenias grisator* | • Sanitation: Collect and destroy all infested leaves and dried twigs. | malathion or a cloth wrapped around the trunk containing chlorpyrifos. |
| Hawk moth<br>*Herse convolvuli* | • Many natural enemies control hawkmoth larvae.<br>• Do weed control around and in field. | • Use of biological control *Basillus thuringiensis.*<br>• Use of insecticides containing lambda cyhalothrin (use formulations 10% and below). |
| Wasps, *Polistes hebraeus; Vespa orientalis* | • Locate and control wasp nests. | • No chemicals are recommended. |
| Powdery Mildew (*Uncinula necator*) | • Monitor in spring to decide when to treat. | • Can use natural controls containing sulfur (dust, wettable, flowable, or micronized), insecticidal soap, potassium bicarbonate, and Organic Stylet (paraffin) Oil are acceptable on most organically certified grapes.<br>• Can use synthetic fungicides containing tebuconazole, triflumizole, myclobutanil, fenarimol, azoxystrobin, trifloxystrobin, kresoxim-methyl (likely carcinogen, PPE essential with repeated use), pyraclostrobin. |
| Black rot<br>*Phyllosticta ampelicida* | • Use resistant cultivars.<br>• Plant vines at optimum spacing to allow aeration and light to enter canopy.<br>• Use trellises to keep grapes off of the ground.<br>• Prune each vine every year during the dormant period. Remove excess growth, diseased and overwintering berries, leaves, and tendrils from the vineyard, and burn or otherwise destroy them.<br>• Keep weed growth near vines under control.<br>• Sanitation: Prune off heavily-infested twigs, after harvest, remove and destroy (or plow under) grape mummies. | • Use natural copper compounds for organic production.<br>• Use synthetic strobilurin fungicides containing pyraclostrobin/, kresoxym-methyl, trifloxystrobin, or azoxystrobin. |
| Anthracnose (*Elsinoe ampelina*) | • Use resistant varieties.<br>• Prune out and destroy (remove from the vineyard) diseased plant parts during the dormant season. This includes infected shoots, cluster stems, and berries. | • Can use dormant liquid lime sulfur in early spring.<br>• Can use synthetic fungicide containing myclobutanil. |

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| | • Eliminate wild grapes near the vineyard.<br>• Prune the vines so that air and sunlight can enter the canopy. | |
| Downy Mildew (*Plasmopara viticola*) | • The pathogen is dispersed by splashing rain and wind.<br>• Use effective soil drainage and reduction of sources of overwintering inoculum.<br>• If sprinkler irrigation is used, extend the intervals between sprays. | • Apply preventive fungicides containing mancozeb, maneb, and copper hydroxide (use only Class II and III products, not Class I) and copper sulfate compounds before an infection period begins.<br>• Apply curative synthetic fungicides containing azoxystrobin, pyraclostrobin, kresoxim-methyl (likely carcinogen, PPE essential with repeated use), mefenoxam, trifloxystrobin. |
| Leaf Spots:<br>Phomopsis cane and leaf spot (*Phomopsis viticola*)<br>*Fusicoceum viticola*<br>*Cryptosporella viticola* | • In spring, monitor for spots in orchard that exhibit poor bud break, map these on an orchard map. Later, check for disease presence in these same areas. | • Dormant treatment: Use fungicide containing liquid lime sulfur during the winter dormant season or at least before first rain, if possible.<br>• Spring foliar treatments: Use of fungicides containing kresoxym-methyl, maneb, azoxystrobin, pyroclostrobin, mancozeb, sulfur and lime sulfur. |
| | **Guava** | |
| Fruit fly<br>*Dacus spp* | • Use resistant grafted planting materials.<br>• Removal of fruit as it matures.<br>• Sanitation: Pruning trees to open up canopy. Cleaning up and destroying dropped infested guavas. | • Use of spinosad combined with liquid attractant as bait sprays on single trees nor lines and mass trapping with 1 trap/ha. |
| Caterpillars:<br>Common guava blue butterfly larva, *Virachola = Deudorix Isocrates;*<br>Castor Hairy Caterpillar, *Euproctis lunata* | • Sanitation: Collect and destroy infested fruits. | • Use insecticides containing carbaryl or synthetic pyrethroids like deltamethrin, or lambda cyhalothrin (use formulations 10% and below), beta cyfluthrin (use formulations 10% and below) or bifenthrin (use only 10% EC and 2.5% ULV formulations). |
| | **Dates** | |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
|---|---|---|
| Date palm weevil<br>*Rhynchophorus ferrugineus* | • Use quarantine to control infested date palm shoots and do regular surveys.<br>• Avoid mechanical damage to trees.<br>• Tarring wounds after pruning a plant of dead or old leaves can also reduce the probability of infestation.<br>• Use pheromone mass trapping and the use of nematodes.<br>• Sanitation: Collect and destroy infested plant material. | • Commercial mixes of pheromones and insecticides called SPLAT are available (see: http://www.iscatech.com/exec/SPLAT.htm).<br>• Can use entomopathogenic fungi *Metarhizium anisopliae*. |
| Rhinoceros beetle<br>*Oryctes rhinoceros* | • Examine trees for infestation and remove the beetles physically.<br>• Put up mercury-vapor lights, following first rains and monsoon, and attached to traps filled with diesel or kerosene to attract and capture beetles.<br>• Collection and destruction of various stages of the beetle from the manure pits.<br>• Soaking of castor cake at 1kg in 5 liters of water in small mud pots and placing them in coconut gardens to attract and kill the adults. | • Can use natural *Metarhizium anisopliae* insecticide mixed into manure piles where beetles lay eggs. |
| White date palm scale<br>*Parlatoria blanchardi* | • Natural enemies and pruning normally keep pest populations at tolerable levels.<br>• Maintain tree vigor: Ensure that plants do not become water-stressed; irrigate and fertilize properly.<br>• Examine palm leaves and leaf bases for discolorations that may be associated with feeding scales, and for developing white scale covers. Heavy infestations give encrusted surfaces a dirty white appearance.<br>• Manage and reduce dust levels in orchard.<br>• Control ant populations in orchard.<br>• Remove plants or plant parts that are repeatedly heavily infested. | • Can use mineral oils during dormant season.<br>• Use "ant stakes" (baited mixes of ant-attractant with insecticides) or traps to control ants.<br>• Can use systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) applied to soil. |
| Date Palm Mites, *Raoiella indica; Brevipalpus rica* | • Need to find and encourage the development of natural enemies of the mites for biological control.<br>• Maintain tree vigor: Ensure that plants do not become water-stressed; irrigate and fertilize properly.<br>• Manage and reduce dust levels in orchard. | • Miticide use is not practical. |
| | **Walnut** | |

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| Walnut Weevil, *Alcides porrestrostris* | • Cultivate under plants to destroy overwintering weevils. | • Chemical controls are not common. |
| Walnut Aphids, *Chromaphis juglandica* | • A number of coccinellid and syrphid predators, parasites and fungal diseases usually keep aphid populations below damaging levels.<br>• Maintain adequate soil moisture and fertilization (Plants stressed for water or nutrients are more susceptible to and suffer greater damage from aphids).<br>• Use regular monitoring, yellow sticky traps.<br>• Sanitation: Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops.<br>• Avoid excessively high soil nitrogen levels. | • Treatments with natural chemicals, if needed, can include narrow range oils, pyrethrin.<br>• No synthetic pesticides are recommended for spraying. |
| Long-horned stem beetle, *Batocera horsfieldi* | • Sanitation: cut or prune and burn dry branches and branch tips in autumn. | • Very difficult to control chemically. |
| Walnut Crown Gall Disease, *Agrobacterium tumefasciens* | • Heat treat planting stock with hot water at recommended temperatures.<br>• Avoid plant injuries.<br>• Use good sanitation:<br>• Remove grow tubes on over-wintering vines. | • Chemical treatments are not generally effective. |
| | **Banana** | |
| Banana weevil<br>*Cosmopolites sordidus* | • Transplant only healthy material, corms free from weevils.<br>• Prior to planting, treat corms with hot water to kill larvae.<br>• Maintain healthy, properly fertilized and vigorous plants.<br>• Hot water treatment of corms.<br>• Baiting/trapping using ground traps with freshly cut corm with or without pheromone Cosmolure.<br>• Do crop rotation.<br>• Cover banana plant wound with soil after pruning or harvesting.<br>• Field sanitation: disc field and clean up crop debris, corms and control weeds. | • Can use synthetic insecticide for commercial production. |
| Banana aphids, *Pentalonia* | • A number of coccinellid and syrphid predators, parasitoids and fungal diseases usually keep aphid populations below damaging | • Use natural insecticides containing neem, pyrethrum, pyrethrins or insecticidal |

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| *nigronervosa* | levels.<br>• Maintain adequate soil moisture and fertilization (Plants stressed for water or nutrients are more susceptible to and suffer greater damage from aphids).<br>• Use regular monitoring and trapping with yellow sticky traps.<br>• Sanitation: Field disking and destruction of crop residues are important for control of aphids.<br>• Avoid excessively high soil nitrogen levels. | soaps. |
| Banana thrips, *Heliotropes species* | • Monitor populations to determine infestation levels.<br>• Bag fruit bunches to exclude thrips. | • Use natural fungal controls such as horticultural oil and insecticidal soaps. |
| Blacktip/fingertip<br>*Botryodiplodia spp*<br>Anthracnose stem and end rot (*Gloeosporium musarum*) | • Use clean and certified material of tolerant varieties.<br>• Use plants produced from disease-free tissue culture.<br>• Use good drainage.<br>• Site selection and preparation: do not use sites with a history of these diseases.<br>• Do canopy management to open up and aerate canopy.<br>• Removal of plant debris, diseased parts and dead leaves.<br>• Avoid damaging fruit. | • Can use synthetic fungicides containing thiophanate-methyl. |
| Pseudo stem rots<br>*Gloeosporium spp*<br>*Botryodiplodia spp*<br>*Erwinia carotovora* | • Use healthy, undamaged disease-free and resistant hybrid planting materials.<br>• Disinfect corms prior to planting.<br>• Maintain good soil drainage and reduce soil humidity.<br>• Sanitation: remove and destroy diseased plants and crop residues.<br>• Careful handling of the fruit to minimize mechanical injuries.<br>• Prompt cooling and maintenance of optimum temperature and relative humidity throughout post-harvest handling operations. | • Can use fungicides and bactericides containing copper compounds. |
| Banana bunchy top virus | • Use clean and certified disease-free material of resistant varieties.<br>• Disinfect cultivation equipment regularly.<br>• Control aphids (the vector). | • Can use carbaryl or systemic insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) to control the aphid vectors of the disease. |
| Yellow Sigatoka leaf | • Use resistant varieties. | • Use natural fungal controls such as |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| spot/sheath rot<br>*Mycosphaerella musicola* | • Use plants produced from disease-free tissue culture.<br>• Use good drainage and apply amino acids complex.<br>• Site selection and preparation: do not use sites with a history of these diseases.<br>• Do canopy management to open up and aerate canopy.<br>• Removal of plant debris, diseased parts and dead leaves. | horticultural paraffin oil and neem oils and antagonist fungi like *Trichoderma lignorum*.<br>• Use of synthetic fungicides containing copper, mancozeb, propiconazole, carbendazim, clorothalonil (formulations less than 50%), and azoxystrobin. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| Banana root nematode (*Radopholus similis*) | • Do not locate seedbeds where vegetables have been grown previously. After preparation of the seedbed, burn the topsoil using dry leaves or other waste plant material.<br>• Solarize seedbeds if possible.<br>• Use biofumigation where possible. Different mustards (e.g. *Brassica juncea* var. *integrifoliaorBrassica juncea* var. *juncea*) should be used as intercrop on infested fields. As soon as mustards are flowering they are mulched and incorporated into the soil. While incorporated plant parts are decomposing in a moist soil, nematicidal compounds of this decomposing process do kill nematodes. Two weeks after incorporating plant material into the soil a new crop can be planted or sown.<br>• Maintain high levels of organic matter (manure and compost) in the soil.<br>• Incorporate neem cake powder into the soil if it is available.<br>• Fields should be ploughed deep and the followed by a dry fallow.<br>• Uproot entire plants from the field after harvest and destroy crop debris.<br>• Crop rotation: Rotate with onions, baby corn, sweet corn, maize, millet, sorghum, sesame, cassava or Sudan grass.<br>• Can use tissue culture or nematode-free transplants for propagation material and hot water treatment.<br>• Use fallow and cover crops.<br>• Use 2 kilos of compost per plant to enhance soil organic matter and microbial composition.<br>• Prop plants with wires.<br>• Maintain good soil drainage.<br>• Sanitation: Remove or compost crop residues after harvest. Thoroughly clean all equipment with disinfectant water. Do not allow irrigation water to flow from an infested field to other fields without impounding. Prevent animal grazing and movement from infested to uninfested fields.<br>• Marigold (*Tagetes minuta* and *T. patula,* respectively) planted as a trap crop to attract nematodes. After 1-2 months, dig up the Marigolds and roots and destroy. | • Artisanal water extracts of basil, garlic, neem seed may reduce populations.<br>• Use botanical/microbial extracts of *Tagetes erecta* or *Paecilomyces lilacinus*. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | • Can use natural hot water treatment for propagation material. | |
| | **Papaya** | |
| Damping off/stem rot<br>*Pythium aphanidermatum* | • Use resistant varieties.<br>• Practice good soil drainage.<br>• Site selection and preparation: do not use sites with a history of these diseases. | • Can use synthetic fungicides containing chlorothalonil or thiram.<br>• Can use a drench of metalaxyl, Bordeaux mix or a copper oxychloride fungicide. |
| Charcoal and post-harvest rot, *Macrophomina phaseoli* | • Use resistant hybrids.<br>• Eliminate low areas in the field and improve drainage.<br>• Good water management to avoid stressing plants, particularly as the crop approaches the flowering stage.<br>• Crop rotation to nonhost crops, such as small grains, can also help reduce the disease potential.<br>• Practice balanced fertility (do not over-fertilize, especially with nitrogen).<br>• Practice sanitation: plowing crop residues under at the end of the season. | • Can use synthetic fungicides containing carbendazim, chlorothalonil or mancozeb. |
| Anthracnose and dieback<br>*Colletotrichum gloeosporioides*<br>*Glomerella cingulata* | • Dip propagation material in hot water. | • Can use synthetic fungicides containing chlorothalonil, mancozeb, pyraclostrobin or azoxystrobin. |
| Fruit and post-harvest rot<br>*Rhizopus oryzae* | • Use disease-free planting materials.<br>• Use careful harvest and handling to avoid fruit injury.<br>• Use a post-harvest hot-water dip.<br>• Store at 10 degrees C. | • Can use synthetic fungicides containing mancozeb. |
| | **Livestock: Cattle, Buffalo, Sheep, Goats, Donkey, Horse, Camel** | |
| Face flies (*Musca autumnalis*) | • Sanitation: Clean up and remove all fresh animal manure and manure pats.<br>• Find where the face flies hibernate (usually in cracks and other spaces somewhere on the south or west sides of buildings warmed by fall or winter sun) and treat them there. | • Use of ear tags impregnated with synthetic insecticides like abamectin (use formulations below 1.9%), diazinon, chlorpyrifos or a synthetic pyrethroid like deltamethrin. |
| Biting flies/stable fly (*Stomoxys calcitrans*) | • Eliminate development sites such as decomposing vegetation.<br>• If compost piles are maintained, put fresh grass clippings into them | • Chemical control is not usually cost-effective as animals would need to be treated every other day with a |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | and turn them regularly to disrupt face fly breeding. | pyrethroid pesticide. |
| Cattle tick (*Boophilus microplus*) | • Sanitation: Clean up and remove all animal waste.<br>• Use clean syringes if blood entry or transfer occurs.<br>• Check animals routinely for ticks, remove ticks by hand.<br>• Some local aromatic shrubs provide extracts that can be used as tick repellents<br>• Brush removal and mowing the vegetation next to wooded areas.<br>• Rotating cattle away from the most tick-infested pastures and the use of tick resistant cattle breeds. | • Preventive vaccination of cattle against tick-borne diseases.<br>• Treat cattle with miticides containing deltamethrin every 21 days. |
| Cattle screwworm (*Cochliomya hominivorax*) | • Reduce any injuries to the cattle hides, skin or horns.<br>• Monitor cattle daily for wounds or fly larvae.<br>• Remove fly larvae manually. | • No insecticides are recommended. |
| Brucelosis (*Brucella abortus*) | • Use vaccination. | • No disinfectants are recommended. |
| Mastitis bacteria (*Streptococcus* and *Staphilococcus* species) | • Maintain clean technique when milking.<br>• Clean milking equipment daily. | • Treat animal teats with a solution of chlorine or iodine and lanoline. |
| **Construction Site and Building Foundation Termite Control** | | |
| Termites (various species) | • Control can be achieved through improving soil organic matter.<br>• Baits: wood stakes treated with borates.<br>• Deep plowing or hand-digging to dig out queen; insecticide poured into nest.<br>• Use composted instead of fresh mulch. | • Can spray synthetic pesticides containing imidacloprid (recommended for use during vegetative growth, not flowering) and Insect Growth Regulators (IGRs) pyriproxyfen, methoprene.<br>• Can use synthetic insecticides containing chlorpyrifos, fipronil, deltamethrin, or chlorphenapyr. |
| **Mushrooms** | | |
| • Mushroom fly/Fungus gnat (*Megasella agarici; Lycoriella solani*) | • Make sure that manure is well sterilized at high temperature.<br>• Use strict sanitation to keep mushroom flies out of production area.<br>• Use exclusion screens and barriers on windows/doors.<br>• Keep farm clean and neat. | • Can use Koppert Biocontrol Scia-rid product.<br>• Can use pyrethrin and neem-based natural control products. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | • Use yellow sticky traps and electric zappers to trap and kill flies. | |
| • Bacterial Brown Blotch (*Pseudomonas fluorescens*) | • Reduce air-borne dust from casing and air ducts.<br>• Thoroughly pasteurize casing materials.<br>• Minimize splashing and clean tools between uses.<br>• Control mushroom flies, which transfer the bacteria from mushroom to mushroom.<br>• Maintain strict temperature and humidity controls. | • Adding sodium hypochlorite at 150 ppm chlorine to water used in irrigating the crop will control blotch. |
| | **Currants (Red, Black)** | |
| • White pine blister rust (*Cronartium ribicola*)<br>• Gooseberry leafspot (*Pseudopeziza ribis* | • Use resistant varieties.<br>• Prune off older and diseased tissue in late winter and early spring.<br>• Avoid poorly drained, wet soils and hot, dry sites.<br>• Choose cool, moist but well-drained sites. | • Can use synthetic fungicides containing mancozeb. |
| • Currant aphid (*Cryptomyzus ribis*) | • Do not over-fertilize with nitrogen; use slow-release or low N content fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support).<br>• Control ant colonies, which tend aphids. | • Can use natural insecticides containing narrow range oils and insecticidal soaps/fatty acids and potassium salts. |
| • Currant borer (*Synanthedon tipuliformis*)<br>• Gooseberry fruitworm (*Zophodia convolutella*) | • Maintain proper plant vigor.<br>• Use pheromone traps and mating disruption.<br>• Sanitation: Prune off older and damaged tissue in late winter and early spring. | • Insecticides are not recommended. |
| • Currant big bud gall mite (*Eriophyes ribis*) | • Use resistant varieties.<br>• Sanitation: Prune off older and damaged tissue in late winter and early spring.<br>• Using a commercially available strain of the entomopathogenic fungus *Verticillium lecanii*. | • Can use synthetic insecticides containing abamectin (use formulations below 1.9%). |
| | **Persimmon** | |
| • Persimmon trunk and branch borers (*Sannina uroceriformis, Agrilus* | • Reduce tree stress: Maintain plant health and good vigorous growth with proper irrigation, nutrition and pruning.<br>• Avoid pruning from spring to summer while adults are active. | • Insecticide sprays are not generally recommended; however, insecticides containing permethrin may be sprayed or |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| *fuscipennis*) | • Protect trees from injury.<br>• Remove and dispose of dying limbs and dead trees.<br>• Do not pile fresh-cut wood near trees; beetles may emerge from it and attack nearby plants. | insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) may be applied as a soil drench around tree base. |
| • Twig girdlers (*Oncideres cingulata*) | • Maintain plant health and good vigorous growth with proper watering, nutrition and pruning.<br>• Prune out girdled branches and twigs.<br>• Sanitation: Remove and destroy dropped girdled twigs and branches in the fall. | • Insecticide sprays are not generally recommended. |
| Fruit sucking stink bugs:<br>• (*Plautia crossota stali*)<br>• (*Halyomorpha halys* and other species) | • Clean weeds from the area. | • Spray kaolin clay on fruit surfaces to protect them from egg laying, or use insecticidal soaps against stink bugs. |
| • Persimmon psylla (*Trioza diospyri)* | • Hand-clean psyllids from branches and leaves, or use a forceful water stream. | • At bloom stage apply natural insecticides that contain dormant or summer oil and insecticidal soap.<br>• Insecticide sprays are not generally recommended; however, insecticides containing permethrin may be sprayed or insecticides containing imidacloprid (recommended for use during vegetative growth, not flowering) may be applied as a soil drench around tree base. |
| • Mealy bug (*Psuedococcus longispinus*) | • Several predators and parasites control mealy bugs well.<br>• Manage ants that tend the mealy bugs by placing tanglefoot around the tree trunk. | • Spray tree late afternoon with controlled amount of insecticidal soap or vegetable or mineral oil (oils can be phytotoxic) enhanced with alkylsilicones.<br>• Use synthetic insecticides that are systemic like imidacloprid (recommended for use during vegetative growth, not flowering). |
| • Soft and armored scales (*Ceroplastes species, Hemiberlesia rapax, Pseudaulacaspis pentagona)* | • Many predators and parasites control scales, including beetles, bugs, green lacewings and predatory mites.<br>• Monitor for presence of scales and in the summer, crawlers.<br>• Provide plants with good growing conditions and especially | • Use natural dormant or summer oil and insecticidal soap to kill crawlers (larval stage).<br>• During winter and early fall, apply |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | appropriate irrigation.<br>• Prune branches to open them up to light, sun and predators.<br>• Sanitation: Prune off and destroy heavily infested branches.<br>• Manage ants that tend the scales by placing tanglefoot around the tree trunk. | synthetic insecticides containing imidaclorpid or dinotefuran (Safari) as a soil drench around tree base. |
| • Gall and blister mites (*Eriophyid* species) | • Prune and dispose of infested leaves.<br>• Keep plants vigorous with proper irrigation and fertilization. | • Can use miticides such as Acramite, Omite, dimethoate, rotenone/pyrethrin, and lime-sulfur spray. |
| • Thrips (*Ponticulothrips diospyrosi*, *Frankliniella occidentalis*) | • Sanitation: Remove weed and crop residue.<br>• Use yellow and blue traps to monitor or for mass trapping<br>• Use of patches of trap crops.<br>• Crop monitoring for thrips<br>• Use soil mulches.<br>• Do weed control in and around the field. | • Can use natural insecticides containing pyrethrin.<br>• Use synthetic insecticides containing in sect growth regulators diflubenzuron (use formulations less than 25%, most formulations below 25% are GUP, and above 25% are RUP) and pyriproxyfen provide great reduction in thrips emergence. |
| • Whiteflies (various species) | • Use of bright yellow or blue sticky traps for monitoring and control of adult stages.<br>• Integrated crop management includes the crop-free periods to conserve natural enemies.<br>• Plant away from other whitefly host crops like cucurbits or tomato. | • Can use insecticides like dormant oil, Pyrellin and Pyrenone Crop Sprays.<br>• Drench and spray applications of a rotational pesticide program that includes imidacloprid (recommended for use during vegetative growth, not flowering), thiamethoxam (recommended for use during vegetative growth, not flowering), spinosad, pymetrozine and *Trichoderma* species. |
| • Aphids (various species) | • Use of sticky yellow or blue traps.<br>• Weed management to avoid alternative hosts for aphids.<br>• Use of oil garlic based repellents. | • Use of mineral oil sprayings. |
| • Gummosis (*Botrysphaeria dothidia)* | • Use good management practices, which include proper irrigation and fertilization.<br>• Prune out and dispose of dead and dying tissues. | • Can use synthetic fungicide containing kresoxim-methyl. |
| • Crown gall (*Agrobacterium tumefaciens*) | • Use care around trees when mowing, spraying or other activities so they do not get wounded near the soil line (the bacteria enters | • Copper solutions may be sprayed on trees infested with crown gall. |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | through wounds). | |
| • Canker and twig blight (*Phomopsis diospyri*) | • Prune off and dispose of diseased twigs.<br>• Maintain good soil drainage. | • Use copper solutions. |
| • Leaf Spot (*Ascochyta dipsaci*) | • Maintain soil fertility and plant health.<br>• Sanitation: Collect and compost or destroy fallen leaves in the fall. | • Use horticultural or neem oil sprays, and copper solutions. |
| • Fruit grey rot (*Botrytis diospyri*) | • Prune the vines so that air and sunlight can enter the canopy.<br>• Removal of basal leaves or basal lateral shoots at or immediately after berry set (on sunrise side of plant). | • Use natural insecticides containing Organic JMS Stylet Oil and *Bacillus subtilis*.<br>• Use synthetic fungicides containing cyprodinil, fenhexamid, iprodione, pyraclostrobin, boscalid, dichloran, mancozeb. |
| | **Bay Leaf Laurel** | |
| • Bay leaf scales (various species) | • Established natural predators and parasites usually provide sufficient control. | • Use horticultural oil or neem oil on undersides of leaves in later afternoon. |
| • Canker and die-back fungi (*Botryosphaeria* species) | • Keep bay leaf trees healthy by managing and reducing water, mulching, fertilizing lightly and pruning off diseased twigs and branches.<br>• Reduce damage to the trees from field operations. | • Fungicides are generally not effective against canker fungi. |
| • Branch and trunk boring long-horned beetle larvae (Cerambycidae; *Anoplophora and Phoracantha* species) | • Keep plant vigorous by managing water, mulching, fertilizing lightly and pruning off diseased twigs and branches.<br>• Monitor trees and remove any new damage to twigs and small branches, burn pruned branches. | • Insecticides are generally not effective against tree borers. |
| | **Sea Buckthorn** | |
| • Sea buckthorne fruit fly (*Rhagoletis batava*) | • Use resistant cultivars like Baikal and hybrid 18/89. | • Chemical control is not economical. |
| • Sea buckthorne aphid (*Capitophorus hippophaes*) | • Natural parasites and predators usually control aphids without need for chemical controls. | • Chemical control is not economical; however natural pyrethrins or synthetic pyrethroids could be used for control. |
| • Sea buckthorne psyllid (*Psylla hippophaes*) | • Natural parasites and predators usually control aphids without need for chemical controls. | • Chemical control is not economical; however natural pyrethrins or synthetic |

| Sector & Primary Pests | Preventive management IPM tools/tactics to integrate | Curative management IPM tools/tactics |
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| | | pyrethroids could be used for control. |
| | **Honeybees** | |
| • Varroa mites (*Varroa destructor*) | • Use honeybees that are more tolerant of mites, such as the "Russian strain". Choose strains that have higher hygienic behavior, Varroa sensitive hygiene (VHS).<br>• Sample beehives to estimate the degree of infestation.<br>• Screen the bottom boards of the hive.<br>• Use special combs for drone brood that attract mites, and then remove the comb, drones and mites. | • Use inert dusts that cause mites to release from their hosts.<br>• Use a Varroa gate impregnated with a miticide named Apilife VAR (natural essential oils), formic acid, thymol or biopesticide named Sucrocide (sucrose octanoate).<br>• Use a Varroa-specific pesticide containing fluvalinate. |
| • European Foulbrood (*Melissococcus plutonius*) | • Beehives with foul brood should be burned to kill spores that can last up to 40 years in the environment and hive.<br>• Dip beehive parts in sodium hypochlorite to kill bacteria and spores.<br>• Maintain bee nutrition so they are stronger and more resistant. | • Use products containing oxytetracycline hydrochloride (Terramycin). (*Do not use products containing chloramphenicol*) |

References: http://ipmguidelines.org/TreeFruits/content/CH11/default.asp; http://ipm.ifas.ufl.edu/agriculture/index.shtml; http://www.ipm.msu.edu/; http://ipm.wsu.edu/; http://www.gaipm.org/; http://attra.ncat.org/index.php; http://www.agroatlas.ru/en/about/; http://www.ipm.ucdavis.edu/; http://www.pestmanagement.info/npmt/pesticideinfo.cfm?crop=cumin&search=Crop; http://www.inra.fr/hyp3/diseases.html; http://humagro.com/index.html.

To find MRLs for each crop and pesticide, see http://www.mrldatabase.com/ and choose MRLs for the market targeted by each crop, be it USA, EU, Russia or, in the absence of a national MRL database, Codex. A Pakistan MRL database is not known to exist as of PERSUAP drafting.

# Annex 2: Guidelines for Pest Management Plans (PMPs) for Pakistan Crops and Beneficiaries

## What is a PMP? [79]

Pest Management Plans or Guides provide field crop, livestock production or project decision-makers – farmers and farm managers – with best production practices recommendations, usually adapted by region, crop phenology and seasons. The aims of PMPs are to reduce the risks to production from pests by using a combination of best practices, including IPM, Integrated Vector Management (IVM) and Integrated Weed Management (IWM), that maximize crop or livestock health, and thus resilience to or tolerance of pests, and without an over-reliance on pesticides needed when best practices are not followed. Thus, prevention of pests plays a strongly pivotal role in the PMP, followed closely by management of pests when prevention alone is not adequate for the level of control needed or desired.

Who are the PMP's intended audiences and users?

- Farm land preparation and crop production/livestock and project decision-makers
- Farmers
- Farm managers

Why is a PMP being done?

### PMP Objectives:

- Prevent or reduce pest damage risk to agricultural production or health
- Protect the health of farmers, farm family members, laborers and community members from pesticide risks
- Maintain economically sound practices
- Reduce environmental pollution and degradation risks
- Enhance the overall quality and quantity of biodiversity on the sustainable farm work environment
- Respond to foreign market demand for the use of agriculture sector best management practice standards, also called Good Agriculture Practices (GAPs) which include IPM measures, to achieve farm and produce certification
- Comply with local, regional, donor and international laws, conventions, and regulations

### Organization of the PMP

The following pieces of crop- or livestock-specific background information are used to build a PMP base

- General information on the crop/livestock/sector
- Crop/livestock common/species names:
- Crop/livestock developmental stages:
- Production regions and how they differ by soil type, pH, fertility, etc.

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[79] PMPs or Year-Round (seasonal) IPM Programs are state of the art in many developed countries, and they help institutionalize IPM in planning and practice. PMPs provide agriculture managers and farmers with a tool to predict and prevent many crop pests of each crop throughout a season. See examples of PMPs at http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html, upper left corner under "Year-Round IPM Programs". Projects may use or modify PMPs as they see fit.

- Overall concerns and priorities for crop/livestock production
- Crop/livestock cultural best practices
- Crop/livestock Good Agriculture Practices (GAPs) including some IPM (see PERSUAP section on GAPS and IPM) recommendations

**Individual Pest Prevention and Management Sections for each of the following pest types:**

- Invertebrate (Insects, Mites, Slugs/Snails, Nematodes)
- Diseases (Fungi, Bacteria, Viruses, Other)
- Weeds (annual grasses, broadleaves, perennial grasses, broadleaves, sedges, others)
- Vertebrates (birds, rodents, other)

For each pest type, first, identify overall priorities for pest prevention and management in the target crop or livestock.

Next, identify individual pest species noting the type of damage incurred; part of plant damaged: roots/rhizomes/tubers, stems/stalks, leaves, florescence, or seeds (field or stored); or if livestock, part of animal affected.

To best understand how to manage a pest, one needs to understand how, where, when and on what parts of the plant or animal the pest feeds. For field pests and stored grain/food pests, many PMPs are designed and outlined as follows containing the following information, *for each major species of pest (insects, mites, slugs/snails, nematodes)*:

- Photographs of each pest, life stages
- Photographs of plant or livestock damage
- Description of the pest, life cycle and survival strategies[80]:
- Description of damage symptoms
- Best Prevention Practices
    - Use any and all of the above GAPs including IPM
    - Country or region-specific information
- Best Management Practices
    - Focus on prevention (above)
    - Country or region-specific information

**Information on PMP-recommended pesticides:**

Information needed for each pesticide referenced in the above PMP, by pest (so the farmer/farm manager has the information at their fingertips and do not need to refer to other documents and tables to find it):

Pesticide essential information needed

- Active Ingredient (AI) name
- Product Trade names (with EPA and WHO Acute Toxicity Classifications in parenthesis)

[80] Survival strategies: All pests have survival strategies that allow them to live and breed in each crop's farming systems. Knowing the survival strategies, including overwintering habit and alternate host plants, that are employed by the pest can help with decision making at the farming systems-level (e.g. choice of rotation crops) and also can help to anticipate pest outbreaks.

- Amounts to use per hectare
- PHI
- Special comments on best application methods and frequency
- Specialized training/certification/permits for use of RUPs
- Any resistance management strategies needed
- Pesticide application record sheet
- Guidelines for reducing spray drift
- Re-entry interval (REI): field safe re-entry period after spraying
- Maximum residue levels (MRL) permitted by markets
- Pesticide precautions with use including
- Reading the label
- Legal responsibilities and permitted registration uses
- Permit requirements for possession and use
- Recommended and obligated use of PPE and best practices
- First aid and antidotes
- Transportation best practices
- Storage best practices
- Safe use best practices
- Container disposal best practices
- Leftover pesticide disposal best practices
- Protection of non-pest animals, plants, endangered species and water body quality
- Protect natural enemies & honeybees: http://www.ipm.ucdavis.edu/PMG/r584310111.html
- Posting signage in treated fields
- Some chemicals not permitted on processed crops
- Potential for phytotoxicity (crop injury) on some crops
- Documentation and record-keeping on farms

Information needed on Natural Enemies of Pests:

Common Names of Predators and Parasitoids effective against above pests: For a list of common natural enemies of crop pests, see http://www.ipm.ucdavis.edu/PMG/NE/index.html. Genera will likely be the same around the world, with different species in different continents, filling similar niches.

Additional Information Needed:

Will there be an IPM Coordinator, an IPM Advisory Committee, Education and Licensing for Applicators, Currency and Approval of the PMP?

## Annex 3: Elements of IPM Program

According to FAO[81], although farmers are likely using numerous IPM tactics, without really calling them that, IPM philosophy or planning is not generally an active part of crop production in Pakistan plots; thus, a basic understanding of the steps or elements needed in an IPM program are addressed below.

### Step 1: Learn and value farmers' indigenous IPM tactics

Most farmers are already using their own forms of GAPs and IPM, many of which are novel, self-created, adapted for local conditions, and many of which work well. These local tools and tactics need to be well understood and taken into account when making PMPs. Accurate assessments of these farmer's GAP and IPM technologies, as well as an understanding of actual losses due to different constraints in farmers' fields are required before designing a crop production and pest management program. S&C farmers will have records of historical pesticide use and trends, as well as information on current use of artisanal or local IPM tactics.

### Step 2: Identify key pests for each target crop

Although perhaps up to ten species of pests may impact a crop and yields at different plant growth stages, generally only two or three are considered serious enough to spend money controlling. Farmers should be encouraged to monitor their population size, their life cycle, the kind of damage they cause and actual losses. Note that crop loss figures based on farmers' perceptions of damage and loss are often overestimated.

### Step 3: Evaluate all management options

Use of best management practices, preventive measures, and "organic" options to control pest impacts may eliminate the need for synthetic pesticides.

### Step 4: Choose IPM methods, identify Needs and Establish Priorities

Continue dialog with project field staff, ministry extension staff and farmers when choosing methods to be used. Consider the feasibility of attractive methods, including the availability of resources needed, farmers' perceptions of pest problems, their abilities to identify pests, their predators, diseases and parasites, and to act upon their observations.

### Step 5: Do effective activities and training to promote IPM

Next, identify strategies and mechanisms for fostering the transfer of the needed IPM technology under various project and institutional arrangements, mechanisms, and funding levels. Define what is available for immediate transfer and what may require more adaptation and validation research. Set up an initial planning workshop (with a COP-supported and signed Action Plan) to help define and orient implementation activities, and begin to assign individual responsibilities.

*Learning-by-doing/discovery training programs*

The adoption of new techniques by small-, medium- and large-holder farmers occurs most readily when program participants acquire knowledge and skills through personal experience, observation, analysis,

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[81] http://www.fao.org/docrep/006/ad487e/ad487e00.htm; http://www.fao.org/docrep/006/ad487e/ad487e02.htm; http://en.wikipedia.org/wiki/Farmer_Field_School; http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html

experimentation, decision-making and practice. At first, frequent (usually weekly) sessions are conducted for 10–20 farmers during the cropping season in farmers' fields by trained instructors or extension agents.

*Smallholder support and discussion groups*

Weekly meetings of smallholders, held during the cropping season, to discuss pest and related problems can be useful for sharing the success of various control methods. However, maintaining attendance is difficult except when there is a clear financial incentive (e.g., credit).

*Educational material*

In many countries, basic written and photographic guides to pest identification and crop-specific management techniques are unavailable or out of date. Videos featuring graphic pictures of the effects of acute and chronic pesticide exposure, and interviews with poisoning victims can be particularly effective.

*Youth education*

Promoting and improving the quality of programs on IPM and the risks of synthetic pesticides has been effective at technical schools for rural youth. In addition to becoming future farmers, these students can bring informed views back to their communities.

*Food market incentives (especially important in the last decade)*

Promoting Organic, GlobalGAP, BRC, Fair Trade or other certification for access to the lucrative and rapidly growing S&C systems-driven international and regional food markets can be, and is, a strong incentive to adopt IPM.

### Step 6: Partner successfully with other IPM implementers

The following design steps are considered essential.

*Articulate the partnership's vision of IPM*

Organizations may forge partnerships based on a common commitment to "IPM" – only to discover too late that that their visions of IPM differ considerably. It is therefore highly important that partners articulate a common, detailed vision of IPM, centered on the crops and conditions the project will encounter.

*Confirm partner institutions' commitment*

The extent of commitment to IPM integration into project, design, and thus implementation depends strongly upon the following key variables:

*IPM program integration into larger project*

The IPM program is likely to be part of a larger "sustainable agriculture" project. The IPM program must fit into a partner's overall goals. The extent of this integration should be clearly expressed in the proposed annual work plan.

*Cost sharing*

The extent of funds (or in-kind resources) is a good measure of a genuine partner commitment.

*Participation of key IPM personnel*

Organizations should have staff with expertise in IPM. In strong partnerships, these staff members are actively involved in the partnership.

### Step 7: Monitor the fields regularly

At minimum twice a week, farmers should monitor their fields for pests, as some pest populations increase rapidly and unexpectedly; this increase is usually related closely to the stage of crop growth and weather conditions, but it is difficult to predict the severity of pest problems in advance.

### Step 8: Select an appropriate blend of IPM tools

A good IPM program draws from and integrates a variety of pest management techniques, like those presented in the above list. Flexibility to fit local needs is a key variable. Pesticides should be used only if no practical, effective, and economic non-chemical control methods are available. Once the pesticide has been carefully chosen for the pest, crop, and environment, it should be applied only to keep the pest population low, not necessarily eliminate it.

### Step 9: Develop education, training, and demonstration programs for extension workers

Implementation of IPM depends heavily on education, training, and demonstration to help farmers and extension workers develop and evaluate the IPM methods. Hands-on training conducted in farmers' fields (as opposed to a classroom) is a must. Special training for extension workers and educational programs for government officials and the public are also important.

### Step 10: Monitoring, Record-Keeping and Evaluation (M&E)

Develop data collection forms and checklists, collect baseline GAP/IPM data at the beginning of the project, and set targets.

For the use and maintenance of Good Agriculture Practices (that include safe pesticide storage, use and disposal), maintain farm or project files of: farmer and farm employee training records certification; farm soil, water, biodiversity, cropping and pesticide use maps; pesticide purchase and stock records; chemical application instructions including target pest, type of chemical applied, dosage, time of spray, rates at which pesticides were applied, harvest interval days, application machinery, PPE required and used, and any special instructions on mixing, exposure to children or dangers. Further, for project staff, beneficiaries, produce processing facilities, food warehouses, seed multipliers, or farmers that store seed or food and deal with stored seed and food pests, there are warehouse BMPs and monitoring reports that incorporate some IPM tactics. These monitoring forms track, by location or warehouse, use of pallets, stacking, general hygiene and sanitation, damaged packages, actual infestations or signs of rodents, molds, insects, drainage, locks and security measures, use of IPM tactics including least toxic chemicals and strict BMPs for use of common but hazardous fumigants like aluminum phosphide.

# Annex 4: Natural Pesticides that Have Been Commercialized

**Insecticides**[82]

| | |
|---|---|
| azadirachtin—component in neem oil | botanical extract |
| *Bacillus thuringiensis-BT* | microbial |
| *Beauveria basiana* | microbial |
| cartap hydrochloride | marine worm (*Lumbriconereis heterodopa*) extract |
| chili pepper extract | botanical (spice) |
| emamectin benzoate | botanical extract |
| garlic extract/allicin | botanical extract (spice) |
| harpin protein | plant induced resistance elicitor |
| kaolin clay | inorganic mineral |
| d-limonene | citrus extract (spice) |
| *Metarhizium anisopliae* | microbial |
| narrow range dormant oil | paraffin oil |
| neem oil | botanical extract |
| nuclear polyhedrosis virus (NPV) | microbial |
| *Paecilomyces lilacinus* | microbial |
| *Paecilomyces fumosoroseus* | microbial |
| pyrethrin | botanical extract |
| pyrethrum | botanical extract |
| pyriproxyfen | IGR (Juvenile Hormone mimic) |
| ryania | botanical extract |
| soap (insecticidal) | fatty acids |
| spinosad | microbial extract |
| buprofezin | IGR (Chitin Synthesis inhibitor) |

[82] Reference: Compiled from Annexes 1 and 7, and from other of Alan Schroeder's PERSUAPs.

**Fungicides**

| | |
|---|---|
| *Bacillus subtilis* | microbial |
| Bordeaux mix | inorganic (Bordeaux ingredients EPA registered) |
| copper | inorganic |
| copper hydroxide | inorganic |
| copper oxychloride | inorganic |
| copper sulfate | inorganic |
| harpin protein | plant induced resistance elicitor |
| sulfur | inorganic |
| *Trichoderma spp.* | microbial |

**Nematocides**

| | |
|---|---|
| *Myrothecium verrucaria* | microbial |
| tomatillo oil + thyme oil extracts (Promax[83]) | botanical + spice extracts—soil biopesticide |

**Molluscicide**

| | |
|---|---|
| iron phosphate | inorganic |

[83] http://www.bhn.name/humagro/biopesticides.html

## Annex 5: Botanical Pesticides, Repellents, and Baits Regulated by USEPA

### TABLE 18: BOTANICAL PESTICIDES, REPELLENTS, AND BAITS REGULATED BY USEPA

| Name | Other Names | Use | Toxicity | EPA Tracking Number |
|---|---|---|---|---|
| Allium sativum | Garlic | Repels insects | Low | 128827 |
| Allyl isothiocyanate | Oil of Mustard | Kills & repels insects | Questionable | 004901 |
| Anise Oil | Repels vertebrates | Low | 004301 | |
| 4-allyl anisole | Estragole | Kills beetles | Low | 062150 |
| Azadirachtin | *Azadirachta indica* Neem tree extract | Kills & repels insects | Low, IV | 121701 |
| Bergamot | | Repels vertebrates | | 129029 |
| Canola Oil | *Brassica Napus B. Campestris* | Kills many insects | Low | 011332 |
| Capsaicin | *Capsicum frutescans* | Repels vertebrates | Low, III | 070701 |
| Castor Oil | | Repels vertebrates | Low | 031608 |
| Cedarwood Oil | | Repels moth larvae | Low | 040505 |
| Cinnamaldehyde | *Ceylon and Chinese* cinnamon oils | Kills insects, fungi & repels vertebrates* | Low | 040506 |
| Citronella Oil | | Repels insects & vertebrates | Low | 021901 |
| Cloves, Crushed | | | Low | 128895 |
| Dihydroazadirachtin | Neem tree extract *Azadirachta indica* | Kills & repels insects | III-IV | 121702 |
| Eucalyptus Oil | | Repels insects, mites fleas & mosquitoes | Low | 040503 |
| Eugenol | Oil of cloves | Kills insects** | Low | 102701 |
| Geraniol | Oil of rose isomeric w/ linalool | Repels vertebrates** | Low | 597501 |
| Geranium Oil | | | Low | 597500 |
| Indole | from all plants | Trap bait: corn rootworm beetles | Low | 25000- |

| | | | | |
|---|---|---|---|---|
| Jasmine Oil | | | Low | 040501 |
| Jojoba Oil | | Kills & repels whitefly kills powdery mildew | Low | 067200 |
| Lavandin Oil | | Repels clothes moth | Low | 040500 |
| Lemongrass | | Repels vertebrates | Low | 040502 |
| Linalool | Oil of Ceylon isomeric w/geraniol | Repels insects, ticks, mites & spiders | Low | 128838 |
| Maple lactone | | Roach trap bait | Low | 004049 |
| Methyl salicylate | Oil of wintergreen | Repels moths, beetle & vertebrates | May be Toxic in large quantity | 76601- |
| Mint | Herb | Kills aphids | Low | 128892 |
| Mint Oil | | Kills aphids | Low | 128800 |
| Mustard Oil | | Repels insects, spiders & vertebrates | Low | 004901 |
| Neem Oil | | Kills whitefly, aphids | Low | 025006 |
| 1-Octen-3-ol | From clover, alfalfa | Trap bait: mosquitoes | Low | 69037- |
| Orange | | Repels vertebrates | Low | 040517 |
| p-Methane-3,8 diol | *Eucalyptus sp.* | Repels biting flies, mosquitoes | Low | |
| 2-Phenylethyl-propionate | From peanuts | Kills insects, ticks, mites & spiders | Low | 102601 |
| Pyrethrum | *Chrysanthemum sp.* | Stored products use | III | |
| Red pepper | Chilli | Repels insects | Low | 070703 |
| Rosemary | Herb | | Low | 128893 |
| Rotenone | *Derris sp., Tephrosia* | Controls ticks | III | |
| Ryania | *Ryania speciosa* | Kills thrips, codling moth, corn borers | | |
| Sabadilla | *Schoenocaulon sp.* | | III | |
| Sesame Oil | *Sesamum indicum* | Pyrethroid synergist | Low | |
| Soybean Oil | Soja | Kills insects, mites | Low | 031605 |
| Thyme | Herb | Controls aphids | Low | 128894 |

| | | | | |
|---|---|---|---|---|
| 1,2,4 Trimethoxy-benzene | From squash | Trap bait: corn rootworm, cucumber beetles | Low | 40515- |
| Verbenone | From pine trees | Repels bark beetles | Low | 128986 |

* attracts corn rootworm beetles, ** attracts Japanese beetles. Not all plant extracts are listed. More detailed information available for most oils: http://www.epa.gov/pesticides/reregistration/status.htm. Natural Source: Only one or a few sources are listed. Most of these chemicals are found in many different plants.

Since the time in the late 1990s when EPA did register biological ingredients listed above, it has since developed a list of botanical extracts (mostly essential oils) under "Minimum Risk Pesticides Exempted under Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Section 25(b)"[84]. Some of the very same ingredients are in both lists. However, most US states and USAID consider botanical extracts and essential oils used to kill, destroy, mitigate, or repel pests to be analyzed and treated as pesticides.

[84] http://www.epa.gov/oppbppd1/biopesticides/regtools/25b_list.htm

# Annex 6: Toxicity Of Pesticides: EPA and Who Classifications

## General Toxicity

Pesticides, by necessity, are poisons, but the toxicity and hazards of different compounds vary greatly. Toxicity refers to the inherent intoxicating ability of a compound whereas hazard refers to the risk or danger of poisoning when the pesticide is used or applied. Pesticide hazard depends not only on toxicity but also on the chance of exposure to toxic amounts of the pesticide. Pesticides can enter the body through oral ingestion, through the skin or through inhalation. Once inside the body, they may produce poisoning symptoms, which are either acute (from a single exposure) or chronic (from repeated exposures or absorption of smaller amounts of toxicant).

## EPA and WHO Toxicity Classifications

Basically, there are two systems of pesticide toxicity classification. These are the USEPA and the WHO systems of classification. It is important to note that the WHO classification is based on the active ingredient only, whereas USEPA uses product formulations to determine the toxicity class of pesticides. So, WHO classification shows relative toxicities of all pesticide active (or technical) ingredients, whereas EPA classification shows actual toxicity of the formulated products, which can be more or less toxic than the active ingredient alone and are more representative of actual dangers encountered in the field. The tables below show classification of pesticides according to the two systems.

### TABLE 19: USEPA CLASSIFICATION (BASED ON FORMULATED PRODUCT=ACTIVE INGREDIENT PLUS INERT AND OTHER INGREDIENTS)

| Class | Descriptive Term | Mammalian $LD_{50}$ | | Mammalian Inhalation $LC_{50}$ | Irritation | | Aquatic invert/fish ($LC_{50}$ or $EC_{50}$)[2] | Honey bee acute oral ($LD_{50}$) |
|---|---|---|---|---|---|---|---|---|
| | | Oral | Dermal | | Eye[1] | Skin | | |
| I | Extremely toxic | ≤50 | ≤200 | ≤0.2 | Corrosive | Corrosive | I | Extremely toxic |
| II | Highly toxic | 50-500 | 200-2000 | 0.2-2.0 | Severe | Severe | 0.11-1.0 | < 2 µg/bee |
| III | Moderately toxic | 500-5000 | 2000-20000 | 2.0-20 | No corneal opacity | Moderate | 1.1-10.0 | 2.1-11 µg/bee |
| IV | Slightly toxic | ≥5000 | ≥20000 | ≥20 | None | Moderate or slight | 10.1-100 | |
| | Relatively non-toxic | | | | | | 101-1000 | |
| | Practically non-toxic | | | | | | 1001-10,000 | > 11 µg/bee |
| | Non-toxic | | | | | | > 10,000 | |

[1] Corneal opacity not reversible within 7 days for Class I pesticides; corneal opacity reversible within 7 days but irritation persists during that period for Class II pesticides; no corneal opacity and irritation is reversible within 7 days for Class III pesticides; and Class IV pesticides cause no irritation

[2] Expressed in ppm or mg/l of water

### TABLE 20: WHO CLASSIFICATION (BASED ONLY ON ACTIVE OR 'TECHNICAL' INGREDIENTS)

| Class | Descriptive term | Oral $LD_{50}$ for the rat (mg/kg body wt.) | | Dermal $LD_{50}$ for the rat (mg/kg body wt.) | |
|---|---|---|---|---|---|
| | | Solids | Liquids | Solids | Liquids |
| Ia | Extremely hazardous | ≤5 | ≤20 | Ia | Extremely hazardous |
| Ib | Highly hazardous | 5-50 | 20-200 | Ib | Highly hazardous |
| II | Moderately hazardous | 50-500 | 20-2000 | II | Moderately hazardous |
| III | Slightly hazardous | ≥501 | ≥2001 | III | Slightly hazardous |
| U | Unlikely to present acute hazard in normal use | ≥2000 | ≥3000 | U | Unlikely to present acute hazard in normal use |

# Annex 7: Analyses of Active Ingredients in Pesticides Found in Pakistan

## Introduction to Annex 7

Annex 7 below compiles all of the AIs in pesticides (natural and synthetic) registered for use in Pakistan. Project decision-makers—especially those who interface at the field level with beneficiary farmers—are encouraged to look at the label of potential pesticide choices to determine the AIs contained in them and then use this Annex as a quick reference guide to attributes and issues with each chemical.

The pesticide attributes include pesticide class (to manage resistance by rotating chemicals from different classes), EPA registration and Restricted Use Pesticide (RUP) status (to comply with Regulation 216) and acute toxicity (judged by this document to be safe, or not, for small-holder farmers—most Class I chemicals are not considered safe for smallholder farmers to use). Annex 7 also presents chronic health issues, water pollution potential, and potential toxicities to important non-target organisms like fish, honeybee pollinators, birds and several aquatic organisms.

Further, Annex 7 contains basic pieces of human safety and environmental data needed for the various analyses required throughout the PER; ergo it is referred to throughout this document. And it provides data used to produce the project-critical information contained in Annex 9. Thus, this PERSUAP provides useful tools for evaluating and choosing among IPM options, including natural and synthetic pesticides, while adhering to 22 CFR 216, as well as aiming at the market-driven best practices found in Standards and Certification (S&C) systems—the highest international standards available.

See Annex 7 Matrix, below.

### Key to Pesticide Analysis Matrix

Red shading: Do not promote during ACT BDS or GlobaGAP extension and training any products containing AIs shaded in red color

Yellow shading: Caution; Promote during GlobalGAP training only product choices containing these AIs which are not designated as RUP (see web pages with specific RUP and non-RUP products for each yellow-shaded AI)

Green shading: Can be promoted for use during GlobalGAP training on ACT-supported farms and farmers

RUP

Few = one or two products; Some = a third of products; Most = all or almost all products; Cotton = RUP only for use on cotton

EU Registration

Yes = registered; No = not registered; NL = not listed; pend = pending registration

WHO Acute Toxicity Classes

O = Obsolete; Ia = Extremely Hazardous; Ib = Highly Hazardous; II = Moderately Hazardous; III = Slightly Hazardous; U = Unlikely to present acute hazard in normal use; NL = not listed

EPA Acute Toxicity Classes

I = Extremely Toxic; II = Highly Toxic; III = Moderately Toxic; IV = Slightly Toxic; NL = not listed

Chronic Human Toxicity

KC = Known Carcinogen; LC = Likely Carcinogen; PC = Possible Carcinogen; ED = Potential Endocrine Disruptor; RD = Potential Reproductive & Development Toxin; P = Risk of Parkinson's; NL = none listed

Ecotoxicity

PNT = Practically Not Toxic; NAT = Not Acutely Toxic; ST = Slightly Toxic; MT = Moderately Toxic; HT = Highly Toxic; VHT = Very Highly Toxic; empty space = information not known and unavailable

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| | | | | | | | | | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Active Ingredients** | **Class** | **Special Use Sector** | **EPA Registered** | **Restricted Use Pesticide** | **WHO Acute Toxicity Class** | **EPA Acute Toxicity Classes** | **Chronic Toxicity** | **Groundwater contaminant** | **fish** | **bees** | **birds** | **amphibians** | **worms** | **Mollusks** | **Crustaceans** | **Aquatic Insects** | **Plankton** |
| **Fumigants** | | | | | | | | | | | | | | | | | |
| aluminum phosphide | inorganic | W | yes | **all** | NL | **I** | NL | no data | HT | HT | HT | | MT | | MT | | |
| magnesium phosphide | inorganic | W | yes | **most** | NL | **I** | NL | no data | MT | | HT | | MT | | | | |
| methyl bromide | halogenated organic | W | yes | **all** | NL | **I** | RD, ED | no data | MT | PNT | | MT | MT | MT | MT | MT | MT |
| **Insecticides** | | | | | | | | | | | | | | | | | |
| abamectin | microbial extract | G | yes | **some** | NL | II, III | ED, RD | no data | ST | HT | PNT | | MT | | HT | VHT | VHT |
| acephate | organophosphate | G | yes | no | III | II, III | PC, ED | potential | MT | HT | MT | ST | ST | | ST | | |
| acetamiprid | neonicotinoid | | yes | no | NL | III | NL | potential | NAT | MT | HT | | | | NAT | | |
| acrinathrin | synthetic pyrethroid | | **no** | no | U | IV | ED | no data | MT | ST | MT | | MT | | MT | | |
| alpha cypermethrin | synthetic pyrethroid | W V M | yes | **all** | II | II, III | PC | no data | HT | HT | PNT | | | MT | VHT | VHT | VHT |
| amitraz | formamidine | V | yes | no | III | III | PC, ED, RD | no data | MT | PNT | ST | ST | | | NAT | | ST |
| azadirachtin/neem oil | botanical | G | yes | no | NL | III | ED | no data | ST | NAT | NAT | MT | | | | MT | |
| azinphos methyl | organophosphate | | yes | **most** | **Ib** | **I** | NL | potential | HT | HT | MT | MT | HT | MT | VHT | VHT | MT |
| beta cyfluthrin | synthetic pyrethroid | S W M | yes | **few** | II | II, III | ED | no data | VHT | HT | PNT | | | ST | | VHT | VHT |
| beta cypermethrin | synthetic pyrethroid | | yes | **some** | NL | II, III | PC, ED | no data | HT | HT | ST | | | | HT | | |
| bifenthrin | synthetic pyrethroid | G M T | yes | **some** | II | II, III | PC, ED, RD | no data | VHT | HT | MT | | | | HT | | |
| buprofezin | insect growth regulator | | yes | no | U | II, III | PC | no data | MT | ST | MT | NAT | MT | | | | |
| cadusafos | organophosphate | | **no** | no | **Ib** | NL | NL | no data | HT | HT | HT | | | HT | HT | HT | |
| carbaryl | carbamate | G V | yes | no | II | II, III | **LC**, ED, RD | potential | MT | HT | PNT | MT | VHT | ST | HT | HT | MT |
| carbofuran | carbamate | S | yes | **most** | **Ib** | **I**, II | ED | potential | MT | HT | HT | ST | MT | MT | HT | HT | VHT |
| carbosulfan | carbamate | | **no** | no | II | II | NL | no data | HT | HT | HT | | HT | | HT | | |
| cartap hydrochloride | nereistoxin | | **no** | no | II | II | NL | no data | MT | MT | | | | | | | |
| chlorantraniliprole/rynaxypyr | anthranilic diamide | | yes | no | NL | III | NL | no data | NAT | MT | MT | | MT | | HT | | |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
| chlorfenapyr | pyrazole | T | yes | no | II | III | PC | no data | HT | HT | HT | | | | | | |
| chlorfenvinphos | organophosphate | V | **no** | no | **Ib** | **I**, II | ED | no data | HT | HT | HT | MT | MT | | HT | | |
| chlorfluazuron | benzoyl urea | | **no** | no | **U** | **NL** | NL | no data | ST | MT | ST | | MT | | HT | | |
| chlorpyrifos (ethyl) | organophosphate | S G W T | yes | **some** | II | II, III | ED | no data | HT | HT | HT | MT | PNT | MT | VHT | HT | MT |
| clofentezine | tetrazine | | yes | no | U | III | PC, ED | no data | ST | PNT | ST | | | | | | ST |
| clothianidan | neonicotinoid | | yes | no | NL | III | NL | no data | ST | HT | ST | | | | ST | | |
| cypermethrin | synthetic pyrethroid | V | yes | **some** | NL | II, III | PC, ED, RD | no data | HT | HT | PNT | | | MT | VHT | VHT | VHT |
| cyromazine | triazine | G | yes | no | U | III | ED | **known** | MT | ST | MT | | MT | | MT | NAT | |
| deltamethrin | synthetic pyrethroid | W V M T | yes | **some** | II | **I**, II, III | ED | no data | HT | MT | | VHT | | NAT | | VHT | VHT |
| diafenthiuron | unclassified | | **no** | no | U | NL | NL | no data | HT | MT | MT | | MT | | MT | | |
| diazinon | organophosphate | S G | yes | **some** | II | II, III | ED, RD | potential | MT | HT | VHT | MT | MT | MT | HT | HT | HT |
| dichlorvos/DDVP | organophosphate | G W | yes | no | **Ib** | **I**, II, II, III | PC, ED | no data | MT | HT | HT | | | | HT | | |
| diflubenzuron | insect growth regulator | | yes | **some** | U | III | ED | no data | ST | NAT | PNT | NAT | | NAT | NAT | ST | MT |
| dimehypo/thiosultap | nereistoxin | | **no** | no | NL | NL | NL | no data | | | | | | | | | |
| dimethoate | organophosphate | | yes | no | II | II | PC, ED, RD | potential | ST | VHT | VHT | HT | MT | VHT | HT | VHT | MT |
| emamectin benzoate | botanical | | yes | **all ag** | NL | I, II, III | NL | potential | HT | MT | | | | HT | HT | HT | |
| esfenvalerate | synthetic pyrethroid | | yes | no | II | II, III | ED | no data | VHT | HT | ST | VHT | | ST | HT | | |
| ethofenprox | synthetic pyrethroid | M | yes | no | U | III | PC, ED | no data | HT | HT | MT | | MT | | HT | | |
| fenitrothion | organophosphate | | yes | no | II | II, III | ED | no data | MT | HT | MT | MT | MT | MT | VHT | HT | MT |
| fenoxycarb | insect growth regulator | G | yes | no | U | III | **KC**, ED, RD | potential | VHT | PNT | PNT | | | | | VHT | MT |
| fenpropathrin | synthetic pyrethroid | G | yes | **all** | II | II, III | ED | no data | VHT | HT | MT | VHT | MT | | VHT | VHT | VHT |
| fenthion | organophosphate | | **no** | no | II | II | ED | potential | MT | MT | VHT | VHT | | HT | HT | VHT | VHT |
| fenvalerate | synthetic pyrethroid | V | **no** | no | II | III | ED | no data | VHT | HT | ST | HT | VHT | HT | HT | HT | VHT |
| fipronil | pyrazole | S T | yes | **some** | II | II, III | PC, ED | potential | HT | HT | HT | | | | | HT | HT |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity: fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| flufenoxuron | benzoyl urea | | **no** | no | U | III | NL | no data | HT | ST | MT | | MT | | HT | | |
| gamma cyhalothrin | pyrethroid | | yes | **some** | III | I, II, III | ED | no data | HT | HT | ST | | | | HT | | |
| hexaflumuron | insect growth regulator | | yes | no | U | III | NL | no data | HT | HT | MT | | MT | | HT | | |
| imidacloprid | neonicotinoid | S W | yes | no | II | II, III | NL | potential | NAT | | MT | | | | | VHT | |
| indoxacarb, S isomer | oxadiazine | | yes | no | **O** | III | NL | no data | MT | HT | HT | | NAT | | MT | | |
| lambda cyhalothrin | synthetic pyrethroid | W S V M | yes | **some** | II | II, III | ED | no data | VHT | HT | PNT | | VHT | VHT | VHT | VHT | |
| lufenuron | benzoyl urea | | yes | no | NL | III | NL | no data | MT | ST | MT | | MT | | HT | ST | |
| malathion | organophosphate | G W M | yes | no | III | II | PC, ED | potential | MT | HT | MT | HT | ST | VHT | MT | VHT | HT |
| methidathion | organophosphate | | yes | **most** | **Ib** | **I**, II | PC | potential | MT | ST | HT | | ST | ST | HT | VHT | ST |
| methomyl | carbamate | | yes | **few** | **Ib** | **I**, III | ED | potential | MT | HT | HT | ST | HT | ST | HT | VHT | HT |
| methoprene | insect growth regulator | W M T | yes | no | III | III | NL | no data | ST | ST | NAT | | | ST | HT | VHT | MT |
| methoxyfenozide | diacylhydrazine | | yes | no | U | III | NL | potential | MT | MT | ST | | ST | | | HT | MT |
| metolcarb | carbamate | | **no** | no | II | NL | NL | no data | ST | | | ST | | ST | | MT | |
| monomehypo | nereistoxin | | **no** | no | NL | NL | | no data | | | | | | | | | |
| nitenpyram | neonicotinoid | | **no** | no | II | NL | NL | no data | MT | HT | MT | | MT | | ST | | |
| nuclear polyhedrosis virus (NPV) | microbial | | **no** | no | NL | IV | NL | no data | | | | | | | | | |
| oxydemeton methyl | organophosphate | | yes | **most** | **Ib** | **I** | ED, RD | potential | ST | HT | HT | | MT | | MT | HT | HT |
| oxymatrine | botanical | | **no** | no | NL | NL | NL | no data | | | | | | | | | |
| parafin oil | petroleum | | yes | no | NL | III | NL | no data | NAT | | | | | | | | |
| permethrin | synthetic pyrethroid | G W M | yes | no | II | III | PC, ED | no data | VHT | VHT | PNT | ST | ST | ST | VHT | MT | MT |
| phenthoate | organophosphate | | **no** | no | II | II | ED | no data | HT | HT | MT | | | MT | HT | VHT | VHT |
| phorate | organophosphate | | yes | **most** | **Ia** | **I** | NL | potential | HT | HT | HT | | MT | ST | MT | VHT | VHT |
| profenofos | organophosphate | | yes | **all** | II | III | NL | potential | HT | | | | | | VHT | VHT | VHT |
| profurite aminium | unknown | | **no** | no | NL | NL | NL | no data | | | | | | | | | |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity: fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pymetrozine | triazine | | yes | no | III | III | PC, ED | potential | MT | ST | MT | | MT | | MT | | |
| pyridaben | unclassified | | yes | no | II | II, III | NL | no data | VHT | HT | ST | | MT | | HT | | VHT |
| pyridiphenthion | organophosphate | | **no** | no | III | NL | NL | no data | MT | HT | HT | MT | | | VHT | | |
| pyriproxyfen | insect growth regulator | W T | yes | no | U | III | NL | no data | MT | MT | MT | | MT | | MT | | VHT |
| quinalphos | organophosphate | | **no** | no | II | II | ED | no data | HT | HT | HT | | MT | | | | |
| spinetoram | unclassified | | yes | no | NL | III | NL | no data | MT | | NAT | | MT | | MT | | |
| spinosad | microbial | G W | yes | no | U | III | NL | no data | MT | HT | PNT | | ST | | | HT | MT |
| spiromesifen | keto-enol | | yes | no | NL | III | NL | no data | HT | ST | MT | | MT | | | | |
| spirotetramat | keto-enol | | yes | no | NL | II, III | NL | no data | | MT | MT | | MT | | MT | | |
| tebufenozide | diacylhydrazine | | yes | no | U | III | NL | potential | MT | ST | ST | | MT | | | HT | MT |
| thiacloprid | neonicotinoid | S | yes | no | II | II | PC | no data | | MT | ST | | MT | | | VHT | ST |
| thiamethoxam | neonicotinoid | S | yes | few | NL | III | PC | no data | PNT | HT | PNT | | PNT | PNT | PNT | PNT | |
| thiocyclam hydrogen oxalate | nereistoxin | | **no** | no | II | NL | NL | no data | HT | MT | HT | HT | | | HT | | |
| thiodicarb | carbamate | S | yes | **most** | II | II, III | PC | no data | MT | MT | PNT | | | MT | VHT | | HT |
| tralomethrin | synthetic pyrethroid | | yes | no | II | III | ED | no data | VHT | HT | NAT | | | | HT | | |
| triazophos | organophosphate | | **no** | no | **Ib** | NL | NL | no data | HT | MT | HT | | MT | | HT | | |
| trichlorfon | organophosphate | V | yes | no | II | II, III | PC, ED | no data | ST | PNT | HT | ST | ST | MT | MT | MT | ST |
| triflumuron | insect growth regulator | | **no** | no | U | NL | NL | no data | VHT | ST | MT | | | | MT | MT | MT |
| zeta cypermethrin | pyrethroid | | yes | **some** | **Ib** | II, III | PC, ED | no data | VHT | VHT | NAT | | NAT | VHT | VHT | VHT | |
| **Miticides/Acaricides** | | | | | | | | | | | | | | | | | |
| azocyclotin | organotin | | **no** | no | II | NL | ED | no data | HT | MT | MT | | MT | | HT | | |
| dicofol | organochlorine | G | yes | no | III | II, III | PC, ED | no data | HT | NAT | ST | | MT | MT | HT | MT | MT |
| fenazaquin | inorganic | | yes | no | NL | II | NL | no data | HT | | | | | | | | |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity: fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| fenbutatin oxide | organotin | | yes | **all** | III | **I** | ED, RD | no data | VHT | NAT | MT | | MT | | HT | | VHT |
| fenpyroximate | pyrazole | | yes | no | NL | II | NL | no data | HT | MT | MT | | MT | | HT | | |
| hexythiazox | insect growth regulator | | yes | no | U | III | PC | no data | HT | NAT | MT | | MT | | MT | | |
| propargite | unclassified | | yes | **most** | NL | **I** | PC, RD | no data | HT | PNT | | HT | | | NAT | | HT |
| spirodiclofen | keto-enol | | yes | no | NL | III | PC | no data | MT | HT | NAT | | NAT | MT | MT | MT | |
| | | | | | | | | | | | | | | | | | |
| **Molluscicide** | | | | | | | | | | | | | | | | | |
| metaldehyde | aldehyde | | yes | no | II | II, III | PC | potential | NAT | PNT | MT | PNT | PNT | PNT | PNT | PNT | PNT |
| | | | | | | | | | | | | | | | | | |
| **Rodenticides** | | | | | | | | | | | | | | | | | |
| bromadiolone | coumarin | W | yes | no | **Ia** | III | NL | no data | MT | | MT | | | | MT | | |
| | | | | | | | | | | | | | | | | | |
| **Fungicides** | | | | | | | | | | | | | | | | | |
| azoxystrobin | strobin | S | yes | no | U | III | NL | potential | MT | MT | MT | | MT | | MT | | VHT |
| benomyl (benlate) | benzimidazole | S | **no** | no | U | III | PC, ED, RD | no data | HT | PNT | MT | ST | HT | | NAT | | ST |
| bromothalonil (1,2-dibromo-2,4-dicyanobutane) | | | yes | no | NL | **I** | NL | no data | ST | | | | | | | | ST |
| captan | thiopthalamide | S G | yes | no | NL | **I**, II, III | **KC (hi dose)** | no data | HT | NAT | PNT | MT | | MT | NAT | MT | MT |
| carbendazim | benzimidazole | S | yes | no | U | III | PC, ED | no data | MT | NAT | ST | ST | | | ST | | HT |
| chlorothalonil | chloronitrile | G | yes | no | NL | II, III | PC | potential | VHT | | | HT | | ST | VHT | MT | MT |
| copper ammonium carbonate | inorganic | | yes | no | NL | I | NL | no data | HT | | | | MT | | | | |
| copper hydroxide | inorganic | | yes | no | II | I, II, III | NL | no data | HT | MT | MT | | MT | HT | NAT | HT | HT |
| copper oxychloride | inorganic | | yes | no | NL | II, III | NL | no data | MT | MT | MT | | MT | | | | VHT |
| cymoxanil | unclassified | | yes | no | III | II, III | NL | no data | MT | MT | ST | | MT | | MT | MT | ST |
| cyproconazole | azole | | yes | no | III | III | PC | no data | MT | MT | MT | | MT | | | | MT |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
| difenoconazole | azole | S | yes | no | III | III | PC, ED | no data | MT | MT | ST | | MT | | MT | | HT |
| dimethomorph | morpholine | | yes | no | U | III | NL | potential | MT | MT | MT | | MT | | | | ST |
| diniconazole | triazole | | **no** | no | III | NL | NL | no data | MT | MT | MT | | | | MT | | |
| enestroburin | strobin | | **no** | | | | | | | | | | | | | | |
| epoxiconazole | triazole | | **no** | no | NL | NL | PC, ED | no data | MT | MT | MT | | MT | | | | |
| fenoxanil | amide | | **no** | no | NL | NL | NL | no data | MT | | MT | | MT | | | | |
| fentin hydroxide | organotin | | yes | **most** | II | **I** | PC, ED, RD | no data | MT | MT | HT | | MT | HT | NAT | | VHT |
| fluazinam | phenylpyridinamine | | yes | no | NL | II | PC | no data | VHT | MT | MT | | MT | | MT | | |
| fludioxonil | phenylpyrrole | S | yes | no | U | III | NL | potential | MT | MT | MT | | MT | | MT | | |
| fluquinconazole | triazole | S | **no** | no | NL | NL | NL | no data | MT | MT | MT | | MT | | MT | | |
| flusilazole | azole | | **no** | no | III | III | NL | no data | MT | MT | MT | | MT | | MT | | |
| fosetyl aluminum | unclassified | S | yes | no | NL | II, III | NL | potential | NAT | ST | ST | | MT | | NAT | | MT |
| fthalide/phthalide | unclassified | | **no** | no | U | IV | NL | no data | ST | NAT | | NAT | | NAT | MT | | NAT |
| fungal proteoglycan | biological | | **no** | | | | | | | | | | | | | | |
| hexaconazole | azole | | **no** | no | U | IV | PC | no data | MT | HT | NAT | | MT | | MT | NAT | |
| hymexazol | unclassified | | yes | no | U | II | NL | potential | NAT | | | NAT | | | ST | | ST |
| iprobenfos | organophosphate | | **no** | no | III | NL | NL | no data | MT | MT | MT | MT | | ST | | ST | |
| iprodione | dicarboximide | | yes | no | U | III | **LC**, ED | potential | MT | NAT | ST | | | | HT | | |
| iprovalicarb | unclassified | | **no** | no | U | NL | **KC** | no data | MT | ST | MT | | MT | | | | |
| kasugamycin | antibiotic | | **no** | no | U | NL | NL | no data | ST | | | ST | | MT | | ST | ST |
| kresoxim-methyl | strobin | | yes | no | U | III | **LC** | potential | ST | ST | ST | | MT | | MT | | VHT |
| mancozeb | dithiocarbamate | S G | yes | no | U | III | PC, ED, RD | no data | MT | MT | ST | HT | | | | | NAT |
| mandipropamid | mandelamide | | yes | no | NL | III | NL | potential | MT | MT | ST | | MT | | MT | | |
| mefenoxam (metalaxyl-M) | phenylamide | S | yes | no | II | II, III | NL | potential | MT | NAT | MT | | MT | | MT | | |
| metiram | dithiocarbamate | | yes | no | U | III | PC, ED, RD | potential | ST | PNT | ST | | MT | | MT | | MT |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity: fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| myclobutanil | azole | | yes | no | III | III | ED, RD | no data | MT | ST | MT | | MT | | MT | | HT |
| penconazole | azole | | **no** | no | U | NL | ED | no data | MT | MT | MT | | MT | | MT | | |
| pencycuron | urea | S | **no** | no | U | IV | NL | no data | HT | MT | MT | | MT | | MT | | |
| prochloraz | azole | | **no** | no | III | NL | PC | no data | MT | NAT | MT | | MT | | MT | | |
| procymidone (sumisclex) | unclassified | | **no** | no | U | NL | PC, ED | no data | MT | NAT | | NAT | | MT | MT | ST | MT |
| propamocarb hydrochloride | carbamate | | yes | no | NL | III | NL | potential | MT | MT | MT | | MT | | MT | | |
| propiconazole | azole | | yes | no | II | II, III | PC, RD | potential | MT | | | | | MT | ST | MT | MT |
| propineb | dithiocarbamate Zn | | **no** | no | U | NL | RD | no data | MT | PNT | PNT | | | MT | MT | MT | MT |
| pyraclostrobin | strobin | | yes | no | NL | II, III | NL | potential | ST | MT | MT | | MT | | HT | | |
| pyrimethanil | anilinopyrimidine | | yes | no | U | II, III | PC, ED | no data | MT | | PNT | MT | | MT | MT | MT | |
| quintozene/PCNB | substituted benzene | | yes | no | U | III | PC, ED | no data | MT | | | | | | | | VHT |
| streptomycin sulfate | antibiotic | | yes | no | NL | III | RD | no data | NAT | | | | | | | | |
| sulfur (sulphur, hydrogen sulfide) | inorganic | G | yes | no | U | III | NL | no data | NAT | NAT | NAT | NAT | | | | | NAT |
| tebuconazole | azole | S | yes | no | III | II, III | PC, ED | potential | MT | MT | MT | | MT | | MT | MT | HT |
| thiabendazole | azole | | yes | no | U | III | PC, RD | no data | ST | NAT | | MT | ST | | | | ST |
| thiophanate methyl | benzamidazole | S G | yes | no | U | III | PC, RD | potential | MT | PNT | | NAT | | | ST | | |
| thiram | diothiocarbamate | S | yes | no | III | III | ED, RD | no data | HT | NAT | PNT | VHT | HT | | NAT | HT | HT |
| tolclofos-methyl | chlorophenyl | | **no** | no | U | III | NL | no data | MT | MT | NAT | | MT | | MT | | |
| triadimefon | triazole | G | yes | no | III | II, III | PC, ED, RD | potential | MT | MT | PNT | | MT | | NAT | | |
| triadimenol | triazole | S | yes | no | III | II, III | PC, ED | no data | MT | ST | MT | | MT | | | | |
| tricyclazole | azole | | **no** | no | II | II | NL | no data | MT | MT | MT | ST | MT | | | | ST |
| tridemorph | morpholine | | **no** | no | II | NL | NL | no data | MT | ST | MT | VHT | MT | | | | |
| trifloxystrobin | strobin | S | yes | no | NL | III | NL | no data | ST | ST | MT | | MT | | | | |
| triflumizole | imidazole | | yes | no | III | III | NL | potential | HT | MT | ST | | | | MT | | |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
| triticonazole | azole | S | yes | no | U | III | NL | potential | MT | MT | MT | | MT | | MT | | |
| validamycin | carbohydrate | | **no** | no | U | NL | NL | no data | NAT | HT | ST | NAT | | | | | |
| **Herbicides** | | | | | | | | | | | | | | | | | |
| 2 4 D dimethylamine salt | chlorophenoxy acid | | yes | no | II | **I**, II, III | PC, ED | potential | NAT | | | NAT | | ST | NAT | | NAT |
| 2 4 D sodium salt | chlorophenoxy acid | | yes | no | NL | III | PC | potential | NAT | | | ST | | NAT | NAT | ST | NAT |
| acetochlor | chloroacetanilide | | yes | **most** | III | II, IIII | PC, ED | potential | MT | MT | ST | | MT | | | | MT |
| acifluorfen, sodium salt | nitrophenyl ether | | yes | no | III | **I**, III | PC (hi dose) | no data | MT | | NAT | | | | MT | | |
| alachlor | chloroacetanilide | | yes | **all** | III | **II, III** | KC, ED, RD | known | MT | NAT | NAT | MT | | MT | ST | | ST |
| ametryne | triazine | | yes | no | III | III | ED | potential | ST | MT | NAT | MT | | MT | | | ST |
| amidosulfuron | sulfonylurea | | **no** | no | NL | NL | NL | no data | NAT | MT | MT | | MT | | MT | | |
| aminopyralid triisopropanol-NH3 | pyridine | | yes | no | III | III | NL | no data | MT | MT | ST | | MT | | MT | | |
| atrazine | triazine | | yes | **most** | U | III | PC, ED | **known** | ST | NAT | PNT | ST | ST | ST | ST | ST | ST |
| bensulfuron methyl | sulfonyl urea | | yes | no | U | II, III | NL | potential | NAT | MT | ST | | MT | | ST | | NAT |
| bentazon, sodium salt | benzothiazinone | | yes | no | III | III | NL | **known** | NAT | MT | MT | | MT | ST | MT | | |
| bispyribac-sodium | unclassified | | yes | no | U | III | NL | potential | MT | ST | NAT | | MT | | MT | | |
| bromacil | uracil | | yes | no | U | II, III, IV | PC, ED | **known** | NAT | MT | NAT | | | | ST | | ST |
| bromoxynil | hydroxybenzonitrile | | yes | no | II | II | PC, RD | no data | ST | MT | MT | | MT | MT | | | VHT |
| butachlor | chloroacetanalid | | **no** | no | U | III | PC | no data | HT | MT | NAT | MT | | MT | MT | HT | MT |
| butralin | dinitroaniline | | yes | no | III | **I**, III | NL | no data | HT | MT | NAT | | MT | | MT | | VHT |
| carfentrazone ethyl | triaolinone | | yes | no | III | III | NL | no data | MT | NAT | NAT | | MT | | MT | | MT |
| chlorsulfuron | sulfonyl urea | | yes | no | U | III | RD | potential | ST | MT | ST | | MT | | ST | | HT |
| cinosulfuron | sulfonyl urea | | **no** | no | U | NL | NL | no data | MT | MT | MT | | MT | | ST | | |
| clethodim | cyclohexenone | | yes | no | NL | II, III | NL | potential | MT | MT | MT | | MT | | MT | | |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
| clodinafop-propargyl | a propionic acid | | yes | no | III | II, III | NL | no data | HT | MT | MT | | | | | | |
| clomazone | isoxazolidinone | | yes | no | II | II, III | NL | potential | MT | MT | NAT | | MT | | MT | | HT |
| clopyralid | pyridinecarbxilic acid | | yes | no | NL | II, III | NL | potential | PNT | | PNT | PNT | | | | NAT | |
| cyhalofop-butyl | phenoxypropionate | | yes | no | U | II, III | NL | no data | MT | MT | NAT | | MT | | MT | | |
| dicamba | a benzoic acid | | yes | no | III | II, III | RD | potential | ST | | | NAT | | | NAT | | ST |
| difenzoquat | unclassified | | **no** | no | II | NL | NL | no data | NAT | MT | NAT | | MT | | MT | | |
| diflufenican | anilide | | **no** | no | U | NL | NL | no data | Mt | MT | ST | | ST | | MT | | |
| diquat (dibromide) | bipyridylium | | yes | no | II | II | NL | potential | MT | MT | HT | NAT | MT | MT | ST | | ST |
| diuron | urea | | yes | no | U | III | **KC,** ED, RD | **known** | ST | | | ST | | ST | ST | MT | ST |
| ethalfluralin | dinitroaniline | | yes | no | U | **I**, II, III | PC | no data | MT | MT | MT | | MT | | MT | | HT |
| ethoxysulfuron | sulfonyl urea | | **no** | no | NL | NL | NL | no data | MT | ST | MT | | MT | | | | |
| fenoxaprop-P-ethyl | propionic acid | | yes | no | NL | **I**, II, III | NL | no data | MT | ST | PNT | | ST | | MT | | MT |
| florasulam | triazolopyrimidine | | yes | no | U | NL | NL | no data | MT | MT | MT | | NAT | | NAT | | |
| fluazifop-P-butyl | propionic acid | | yes | no | III | III | NL | no data | MT | ST | PNT | | | | | ST | |
| flucarbazone sodium | triazolone | | yes | no | U | III | NL | no data | MT | ST | MT | | MT | | ST | | |
| flumorph | morpholine | | **no** | no | NL | III | NL | no data | MT | NAT | | | | | | | |
| fluometuron | urea | | yes | no | U | III | PC | potential | ST | | | | | ST | | | MT |
| fluorglycofen-ethyl | diphenyl ether | | **no** | no | II | NL | NL | no data | MT | MT | MT | | HT | | MT | MT | |
| fluroxypyr | pyridine | | yes | no | U | III | NL | no data | MT | MT | MT | | MT | | HT | | HT |
| fluroxypyr methylheptyl ester | pyridine | | yes | no | U | mixture | NL | no data | MT | MT | MT | | MT | | HT | | HT |
| formasulfuron | sulfonyl urea | | yes | no | NL | III | NL | potential | MT | ST | MT | | MT | | MT | | |
| fomesafen | diphehyl ether | | yes | no | III | **I**, II, III | PC | no data | NAT | MT | NAT | | MT | | NAT | | ST |
| glufosinate ammonium | unclassified | | yes | no | NL | II, III | NL | potential | NAT | NAT | MT | | MT | | NAT | | ST |
| glyphosate | phosphonoglycine | | yes | no | U | **I**, II, III | NL | potential | ST | ST | NAT | | PNT | | MT | | ST |
| glyphosate | phosphonoglycine | | yes | no | NL | II, III | NL | potential | ST | | | ST | NAT | ST | NAT | NAT | NAT |

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| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
| isopropylamine salt | | | | | | | | | | | | | | | | | |
| haloxyfop-R-methyl | a propionic acid | | **no** | no | NL | NL | **KC** | no data | HT | MT | MT | | | | MT | | |
| haloxyfop-P-methyl | a propionic acid | | **no** | no | NL | NL | **KC** | no data | HT | MT | MT | | | | MT | | |
| hexazinone | triazinone | | yes | no | III | **I**, III | NL | **known** | NAT | MT | NAT | | | | NAT | ST | ST |
| imazapic | imidazolinone | | yes | no | NL | III | NL | no data | MT | MT | NAT | | | | MT | | |
| imazethapyr | amidazolinone | | yes | no | U | II, III | NL | potential | NAT | HT | NAT | | NAT | | NAT | | |
| iodosulfuron-methyl NaCl | sulfonylurea | | yes | no | NL | III | NL | no data | NAT | PNT | PNT | | ST | | | | |
| isoproturon | urea | | **no** | no | III | NL | NL | no data | MT | ST | MT | | MT | HT | | | |
| isoxaflutole | isoxazole | | yes | **most** | NL | III | **KC** | no data | ST | MT | ST | | MT | | MT | | MT |
| lactofen | diphenyl ether | | yes | no | NL | **I**, III | **LC** | no data | MT | NAT | NAT | | | | MT | | |
| linuron | urea | | yes | no | U | III | PC, ED, RD | potential | MT | NAT | MT | | MT | ST | MT | ST | MT |
| MCPA | chlorophenoxy acid | | yes | no | II | II, IIII | PC | no data | ST | PNT | NAT | ST | | ST | NAT | NAT | ST |
| MCPA-Na | chlorophenoxy acid | | yes | most | NL | **I** | PC | no data | NAT | PNT | NAT | NAT | | ST | ST | NAT | NAT |
| mesosulfuron-methyl | sulfonylurea | | yes | no | NL | II, III | NL | potential | MT | MT | MT | | MT | | MT | | |
| mesotrione | unclassified | | yes | no | NL | II, IIII | NL | no data | NAT | MT | MT | | MT | | NAT | | |
| metazachlor | chloroacetanilide | | **no** | no | U | NL | NL | no data | MT | MT | MT | | | | MT | | |
| metolachlor | chloroacetamide | | yes | no | III | III | PC, ED | **known** | MT | ST | MT | | MT | | MT | | |
| metribuzin | triazinone | | yes | no | II | II, III | ED, RD | potential | MT | NAT | MT | | MT | | ST | | ST |
| metsulfuron | sulfonyl urea | | **no** | no | NL | NL | NL | no data | | | | | | | | | |
| nicosulfuron | sulfonylurea | | yes | no | U | II, III | NL | potential | MT | MT | MT | | MT | | MT | | |
| orthosulfamuron | pyrimadinylsulfonylurea | | yes | no | NL | III | PC | potential | NAT | NAT | MT | | MT | | | | |
| oxadiargyl | unclassified | | **no** | no | NL | NL | NL | no data | MT | NAT | MT | | MT | | NAT | | |
| oxadiazon | oxidiazole | | yes | no | U | II, III | PC, RD | no data | MT | MT | ST | MT | MT | | ST | | HT |
| oxyfluorfen | diphehyl ether | | yes | no | U | II, III | PC | no data | HT | PNT | PNT | | | HT | | HT | HT |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| | | | | | | | | | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Active Ingredients** | **Class** | **Special Use Sector** | **EPA Registered** | **Restricted Use Pesticide** | **WHO Acute Toxicity Class** | **EPA Acute Toxicity Classes** | **Chronic Toxicity** | **Groundwater contaminant** | **fish** | **bees** | **birds** | **amphibians** | **worms** | **Mollusks** | **Crustaceans** | **Aquatic Insects** | **Plankton** |
| paraquat (dichloride) | bipyridylium | | yes | **most** | II | **I** | P | potential | ST | NAT | MT | ST | | ST | ST | NAT | ST |
| pendimethalin | dinitroanaline | | yes | no | III | III | PC, ED | no data | MT | NAT | ST | | | | MT | MT | |
| penoxysulam | triazolopyrimidine | | yes | no | U | III | PC | potential | MT | MT | MT | | NAT | | NAT | | |
| picloram | pyridinecarboxylic acid | | yes | **few** | U | II | ED | **known** | ST | MT | MT | NAT | ST | | NAT | ST | ST |
| pinoxaden | unclassified | | yes | no | III | II, III | NL | no data | MT | MT | NAT | | MT | | | | |
| pretilachlor | chloroacetanilide | | **no** | no | U | NL | NL | no data | MT | MT | ST | | | | MT | | |
| prometryn | triazine | | yes | no | U | III | ED, RD | potential | MT | NAT | PNT | ST | NAT | | NAT | ST | ST |
| propisochlor | chloroacetanalid | | **no** | no | III | III | NL | no data | MT | MT | MT | | | | MT | | |
| prosulfocarb | thiocarbamate | | **no** | no | II | NL | NL | no data | MT | MT | | | MT | | MT | | |
| pyrazosulfuron-ethyl | sulfonylurea | | **no** | no | U | NL | NL | no data | NAT | MT | NAT | | NAT | | | | |
| pyroxsulam | triazolopyrimidine | | yes | **few** | NL | II, III | NL | no data | MT | MT | MT | | NAT | | MT | | |
| quinclorac | quinolinecarboxylic acid | | yes | no | U | III | NL | potential | MT | NAT | MT | | | | MT | | |
| quizalfop-p-ethyl | a propionic acid | | yes | no | NL | **I**, III | NL | no data | MT | MT | MT | | MT | | MT | | |
| s-metolachlor | chloroacetanilide | | yes | no | NL | III | PC, ED | **known** | MT | ST | MT | | MT | | MT | | |
| sulcotrione | unclassified | | **no** | no | NL | NL | NL | no data | | | | | | | | | |
| sulfentrazone | aryl triazolinone | | yes | no | NL | II, III | NL | potential | ST | MT | MT | | | | MT | | MT |
| sulfosulfuron | sulfonyl urea | | yes | no | NL | III | PC | potential | ST | MT | NAT | | MT | NAT | | | NAT |
| tribenuron methyl | sulfonyl urea | | yes | no | NL | III | PC | no data | ST | MT | ST | | MT | | | | |
| terbuthylazine | triazine | | yes | no | U | III | NL | no data | MT | MT | MT | | MT | | MT | | HT |
| terbutryn | triazine | | **no** | no | U | II, III | PC | potential | MT | NAT | NAT | | MT | | MT | | |
| thifensulfuron-methyl | sulfonylurea | | yes | no | U | III | NL | potential | MT | MT | NAT | | NAT | | NAT | | |
| tralkoxydim | cyclohexadione | | yes | no | III | III | PC | potential | MT | | NAT | | | | | | |
| triasulfuron | sufonyl urea | | yes | no | U | III | PC, RD | potential | MT | MT | NAT | | MT | | MT | | |
| trifloxysulfuron sodium | sulfonyl urea | | yes | no | NL | III | NL | potential | NAT | MT | MT | | MT | | NAT | | |

## TABLE 21: PAKISTAN PESTCIDE AIS COMPILED AND ANALYZED

| Active Ingredients | Class | Special Use Sector | EPA Registered | Restricted Use Pesticide | WHO Acute Toxicity Class | EPA Acute Toxicity Classes | Chronic Toxicity | Groundwater contaminant | Ecotoxicity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | fish | bees | birds | amphibians | worms | Mollusks | Crustaceans | Aquatic Insects | Plankton |
| trifluralin | dinitroanaline | | yes | no | U | II, III | PC, ED | no data | HT | PNT | PNT | MT | HT | ST | ST | ST | MT |
| **Plant Growth Regulator** | | | | | | | | | | | | | | | | | |
| flumetralin | dinitroaniline | | yes | no | U | **I**, II, III | NL | no data | VHT | | MT | | MT | | HT | | VHT |
| prosuler (psoralen) | furo-benozopyran | | no | | NL | NL | NL | no data | | | | | | | | | |
| **Microbicides** | | | | | | | | | | | | | | | | | |
| bromine | inorganic | D | yes | no | NL | II | NL | no data | HT | | | | | | | | MT |
| bromine chloride | inorganic | D | yes | no | NL | **I** | NL | no data | HT | | | | | HT | MT | | HT |
| chlorine dioxide | inorganic | D | yes | no | NL | III | NL | no data | NAT | | | | | NAT | NAT | | |
| copper | inorganic | D | yes | no | NL | **I**, II, III | NL | no data | MT | | | VHT | HT | HT | MT | MT | HT |
| formaldehyde | organic | D | yes | no | NL | **I** | **KC** | no data | NAT | | | | | NAT | NAT | | ST |
| hydrogen peroxide | inorganic | D | yes | no | NL | **I**, III | NL | no data | MT | | NAT | ST | | | HT | | |
| iodine | inorganic | D | yes | no | NL | **I**, III | NL | no data | MT | | | | | | | | HT |
| phenol | benzene | D | yes | no | NL | II, III | NL | no data | ST | | | ST | NAT | NAT | ST | NAT | ST |
| quaternary ammonium | inorganic | D | **no** | no | NL | NL | NL | no data | | | | | | | | | |
| sodium hypochlorite (Clorox) | inorganic | D | yes | no | NL | **I**, II, III | NL | no data | HT | | ST | | MT | MT | MT | HT | MT |
| sulfuric acid | acid | D | yes | **few** | NL | **I** | NL | no data | ST | | | | | | ST | | |

Column three coding: Seed = S    Greenhouse Crops = G    Food Security/Warehouses = W    Veterinary = V

Health/Malaria/Dengue = M    Construction/Termites = T    Microbial Disinfectants (Water, Sanitation and Avian Influenza) = D

## Annex 8: Livestock Antibiotics Matrix[85]

| | Type | HMIS Chemical Rating | | | Personal Protection | Chronic Health Issues | Other Spellings and Information |
|---|---|---|---|---|---|---|---|
| | | Health | Fire | Reactivity-Physical Hazard | | | |
| **Endoparasites** | | | | | | | |
| albendazole | benzimidazole | 2 | 1 | 0 | E | possible teratogen<br>mutagenic<br>R&D toxin | Albenza, Zentel, Eskazole |
| dimetridazole (anti-protozoan) | nitroimidazole | 2 | 0 | 0 | E | none | |
| ferbendazole/ fenbendazole | benzimidazole | 1 | 1 | 0 | E | mutagenic | Panacur |
| ipronidazole (anti-protozoan) | | 1 | 0 | 0 | E | none | |
| levamisole (anti-helminth) | imidazothiazole | 2 | 1 | 0 | E | possible R&D toxin | AKA Ergamisole, also spelled as leviamisole, lewamesole |
| nitroimidazole (anti-protozoan) | imidazole | 2 | 0 | 0 | E | | also spelled nitromedazole, AKA Enstryl |
| oxibendazole | benzimidazole | 1 | 0 | 0 | E | possible teratogen<br>possible mutagen<br>R&D toxin | also spelled as oxybendazole, sold as Curafluke |
| oxyclozanide | | 1 | 0 | 0 | E | none | Nilzan ICI |
| piperazine (anti-helminth) | | 2 | 1 | 0 | E | none | also spelled SB piperazine, piprazine, AKA Paprazine |
| **Antibiotics** | | | | | | | |
| bacteracin | sulfamethoxazol | 1 | 1 | 0 | A | | AKA Bactrin-E, Bactrin-F |

[85] Note that HMIS ratings and chronic health issues are for industrial exposure to these chemicals, in quantity.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (antibiotic) | e | | | | | | |
| bromhexine HCl | | 2 | 1 | 0 | J | target organ injury | also spelled bromexene |
| chloroform | | 2 | 0 | 0 | H | known carcinogen mutagenic | also called trichloroform |
| chlorotetracycline (aureomycin) | | 1 | 1 | 0 | E | none | also spelled chloroteracycline |
| ciprofloxacine (antibacteria) | fluoroquinalone | 1 | 1 | 0 | E | none | also spelled ciprofloxacine, AKA Ciprosel |
| clotrimazole (antifungal) | | 1 | 1 | 0 | E | none | AKA Micofix |
| colistin sulfonate (antibacteria) | polymyxin | 2 | 1 | 0 | E | target organ injury | also spelled Colistine |
| enramycin (enduracydin HCl) | | 1 | 0 | 0 | H | | also spelled enromycine |
| enrofloxacin | | 1 | 0 | 0 | E | none | also spelled enroflaxacine |
| enroquine (little known) | | | | | | | |
| flumequine | fluoroquinalone | 0 | 0 | 0 | B | | |
| furazolidone | | 2 | 1 | 0 | E | R&D toxin | |
| gentamicin sulfate | | 2 | 1 | 0 | E | target organ injury | also spelled gentamycine |
| Myco-Ad (anti-mycotoxin) | activated clays | na | | | | | also spelled Mycoad |
| neomycin (antibiotic) | aminoglycoside | 2 | 1 | 0 | E | none | also spelled Neomycine |
| nystatin (antifungal) | | 2 | 1 | 0 | E | none | AKA Nilstate, Nilstat |
| oxytetracycline | tetracycline | | | | | | |
| penicillin | | 1 | 1 | 0 | E | none | also spelled pencilline |
| phosphomycin | | 1 | 0 | 0 | E | possible teratogen R&D toxin | also spelled fasfomycine, part of Fosbac T plus |
| streptomycin | | 2 | 1 | 0 | E | R&D toxin | also spelled streptomycin |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| sulfadiazine | sulfonamide | 2 | I | 0 | E | target organ injury | also spelled sulphadiazine, ingredient in Tribressen(e) |
| sulfadimethoxine | | 2 | I | 0 | E | none | also spelled sulphadimethracine |
| sulfaquinoxaline HCl | | 2 | 0 | 0 | E | target organ injury | also spelled as sulphpaquinegziline |
| tetramisole | | 2 | 0 | 0 | E | none | also spelled tetramizole |
| toltrazuril sulfoxide | | 0 | 0 | 0 | E | none | also spelled toltazuril |
| Triton surfactant | | 2 | 0 | 0 | H | none | also called Tryton X-100, tricolon, risk to aquatic systems |
| tylocine (tylosin) tartrate | | 2 | I | 0 | A | target organ injury | AKA Tylan, Part of Fosbac T plus |

A safety glasses

B safety glasses and gloves

C safety glasses, gloves and an apron

D face shield, gloves and an apron

E safety glasses, gloves and a dust respirator

F safety glasses, gloves, apron and a dust respirator

G safety glasses, a vapor respirator

H splash goggles, gloves, apron and a vapor respirator

I safety glasses, gloves and a dust/vapor respirator

J splash goggles, gloves, apron and a dust/vapor respirator

K airline hood or mask, gloves, full suit and boot

L-Z custom PPE specified by employer

HMIS = Hazardous Materials Identification System

# Annex 9: Phased Training: Pest Management Topics & Safe Pesticide Use

## PHASE 1

**Train project staff and sector leaders on IPM & Safe Use of Pesticides as follows:**

1. 22 CFR 216 compliance process and resulting pesticide lists (use lists 1, 2, and 3 from executive summary and Annex 7 to show any desired pesticides that can be used, used with conditions and cannot be used)
2. 22 CFR 216 required GAP and IPM concepts, tactics and tools found in Annex 1 that can reduce pesticide use and associated risks on specific pests of Pakistan IP target crops
3. PMPs—Pest Management Plans: Making and using these farm crop-management tools (use Annex 2)
4. Pest identification: How to recognize common important pests and diseases (use PMPs developed above)
5. Regulations: International, Local and American treaties and laws that guide pesticide use
6. Monitoring/Spot Treatments: The importance of frequent crop monitoring and use of spot treatments if needed (instead of crop-wide treatments)
7. Natural pesticides: Raise awareness of and promote the use of natural pesticides found in Annexes 1, 4, 5 and 7 as well as green-label synthetic pesticides with relatively low risks
8. REI—Re-Entry Intervals: Pesticide-specific risks associated with entering a sprayed field too soon after the spray operation
9. MRL—Maximum Residue Level: Risks associated with pesticide residues on human food
10. PHI—Pre-Harvest Interval: Pesticide-specific risks associated with harvesting a crop before pesticides have had a chance to break down
11. Vulnerable individuals: The importance of keeping children, pregnant women, elderly and infirm away from the field while spraying and kept out after spraying
12. Understanding pesticides: Types, classes, registration and acute toxicities of commonly-used pesticides (Annex 7)
13. MSDS: How to use MSDSs for pesticide-specific information on risks and risk reduction measures
14. Human and environmental risks: Risks associated with more commonly-used pesticides (use information from MSDSs and Annex 7)
15. When to spray: Early in the morning or late in the afternoon, without wind or rain
16. Use of recommended PPE: Why it is used (see product MSDSs, product labels and web reference below)
17. Safe Use: How to transport, store and use pesticides safely (see safe use web references below and MSDSs)
18. Choice and Maintenance of PPE, sprayers and spray nozzles
19. Preventing and monitoring for the development of pesticide resistance
20. Proper collection and disposal of pesticide rinsate and packaging (see disposal web reference below and MSDSs)
21. The use of pesticide spray buffer zones or organic production near national parks or headwaters leading to rivers that enter national parks

22. How to reduce and mitigate risks to critical environmental resources and biodiversity (found in PER Factors E and G)
23. Honeybees: Ensuring pesticide applicators notify beekeepers about spray activities, and spray early morning or late afternoon when no heavy winds or rain are present
24. Water Pollution: Raise awareness of pesticides (especially some herbicides) with high ground water contamination potential where water tables are high or easy to reach (use Annex 7 and MSDSs)
25. Exposure routes: Ways pesticides enter the body and ways to mitigate entry (see safe use web references below and MSDSs)
26. Basic first aid: Understanding how to treat pesticide poisonings (see first aid web reference below and MSDSs)
27. Record-keeping: Pesticide used, when used, which crop, how applied, who applied (see Annex 11)
28. Certification and trade issues that can be implemented by the Mission in consultation with the MEO (using trained specialists and Google-searched Global GAP, Organic, Fair Trade websites and guidelines)

## PHASE 2

**Trained (above) Sector Leaders (like lead farmers) train project beneficiaries on IPM & Safe Use of Pesticides as follows:**

1. 22 CFR 216 compliance process and resulting pesticide lists (use lists 1, 2, and 3 from executive summary and Annex 7 to show any desired pesticides that can be used, used with conditions and cannot be used)
2. 22 CFR 216 required GAP (especially agribusiness projects that aim to export produce) and IPM concepts, tactics and tools found in Annex 1 that can reduce pesticide use and associated risks on specific pests of Pakistan IP target crops
3. PMPs—Pest Management Plans: Using these farm crop-management tools (use Annex 2)
4. Pest identification: How to recognize common important pests and diseases (use PMPs developed above)
5. Regulations: International treaties (for projects that export), Local laws (for all) that guide pesticide use
6. Monitoring/Spot Treatments: The importance of frequent crop monitoring and use of spot treatments if needed (instead of crop-wide treatments)
7. Natural pesticides: Raise awareness of and promote the use of natural pesticides found in Annexes 1, 4, 5 and 7 as well as green-label synthetic pesticides with relatively low risks
8. REI—Re-Entry Intervals: Pesticide-specific risks associated with entering a sprayed field too soon after the spray operation
9. MRL—Maximum Residue Level (especially for agribusiness projects that aim at exporting produce): Risks associated with pesticide residues on human food
10. PHI—Pre-Harvest Interval: Pesticide-specific risks associated with harvesting a crop before pesticides have had a chance to break down
11. Vulnerable individuals: The importance of keeping children, pregnant women, elderly and infirm away from the field while spraying and kept out after spraying

12. Understanding pesticides: Types, classes, registration and acute toxicities of commonly-used pesticides (use Annex 7)
13. MSDS: How to use MSDSs (and pesticide label pictograms by illiterate beneficiaries/farmers) for pesticide-specific information on risks and risk reduction measures
14. Human and environmental risks: Risks associated with more commonly-used pesticides (use information from MSDSs and Annex 7)
15. When to spray: Early in the morning or late in the afternoon, without wind or rain
16. Use of recommended PPE: Why and how it is used (use product MSDSs, product labels and web reference below) with PPE demonstrations and subsidized PPE for beneficiaries
17. Safe Use: How to transport, store and use pesticides safely (use safe use web references below and MSDSs)
18. Demos on Choice and Maintenance of PPE, sprayers and spray nozzles
19. Preventing the development of pesticide resistance
20. Proper collection and disposal of pesticide rinsate and packaging (use disposal web reference below and MSDSs)
21. The use of pesticide spray buffer zones or organic production near national parks or headwaters leading to rivers that enter national parks
22. How to reduce and mitigate risks to critical environmental resources and biodiversity (use PER Factors E and G)
23. Honeybees: Ensuring pesticide applicators notify beekeepers about spray activities, and spray early morning or late afternoon when no heavy winds or rain are present
24. Water Pollution: Raise awareness of pesticides (especially some herbicides) with high ground water contamination potential where water tables are high or easy to reach (use Annex 7 and MSDSs)
25. Exposure routes: Ways pesticides enter the body and ways to mitigate entry (use safe use web references below and MSDSs)
26. Basic first aid: Understanding how to treat pesticide poisonings (use first aid web reference below and MSDSs)
27. Record-keeping (especially for agribusiness projects that aim at exporting produce): Pesticide used, when used, which crop, how applied, who applied (see Annex 11)
28. Certification and trade issues that can be implemented by the Mission in consultation with the MEO (using trained specialists and Google-searched Global GAP, Organic, Fair Trade websites and guidelines)

## REPEAT TRAINING ANNUALLY

### Web Safe Pesticide Use Training Resources

**General Mitigation of Potential Pesticide Dangers General Measures to Ensure Safe Use:**
http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, Chapter 13

**EPA Recommended Worker Protection Standards:**

http://www.epa.gov/oppfead1/safety/workers/equip.htm (all types of PPE)

http://www.cdc.gov/nasd/docs/d001701-d001800/d001797/d001797.html (respiratory PPE)

**Routes of Pesticide Exposure and Mitigation of Risks:**

http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, Chapter 13

**Basic First Aid for Pesticide Overexposure:**

http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, Chapter 13

**International PIC & POPs Lists:**

PIC Pesticides and Industrial Chemicals (http://www.pic.int)

POPs Pesticides and Chemicals (http://www.pops.int)

**Pesticide Disposal Options:**

http://www.epa.gov/oppfead1/labeling/lrm/chap-13.htm

## Annex 10: Monitoring for Best Practices on Pakistan Beneficiaries

Name of NARS Staff Responsible for Monitoring Demonstration Farms:

Name of Demonstration Farmer: Crop: Date:

What are the major pests encountered by the farmer?:

Which of the *attached* **Preventive and Curative GAP and IPM** tools and tactics are used by farmer?

Are pesticides used by demo farmer? Yes__ No__

How are pesticides applied? backpack sprayer__ other__

What are the names of the pesticides used?:

Which PPE does farmer have and use? gloves__ overalls __ boots__

mask__ goggles__

Has the farmer had Pakistan IPM and Safe Pesticide Use training? Yes__ No__

Are there any empty pesticide containers scattered in the field? Yes__ No__

Are there signs that the backpack sprayer has leaks? Yes__ No__

Does the farmer understand the pesticide label information? Yes__ No__

Is the pesticide stored safely out of the house or away from kids? Yes__ No__

Does the farmer use gloves for mixing the pesticide with water? Yes__ No__

What time of the day is/are the pesticides applied? ________

Are pesticides applied during rain or windy conditions? Yes__ No__

Are women or children permitted to apply pesticides? Yes__ No__

Is there any evidence that empty pesticide containers are used to store water? Yes__ No__

Does the farmer rinse equipment away from streams and open water? Yes__ No__

Does the farmer wash clothes after applying pesticides? Yes__ No__

How does the farmer dispose of empty pesticide containers? puncture/burry__ burn__

Is there any evidence that pesticides are becoming less effective? Yes__ No__

### TABLE 22: PREVENTATIVE AND CURATIVE GAP AND IPM OPTIONS

| Preventive | Preventive | Curative |
|---|---|---|
| Soil nutrient, texture and pH testing | Farmer ability to correctly identify pest predators, parasites and diseases | Mechanical insect control by hand picking |
| Pest resistant/tolerant seed/plant variety | Weekly field scouting to assess pest levels/damage | Farmers make & apply local artisanal plant extracts (neem, pyrethroid, garlic, chili, other) |
| Early/late plantings or harvestings to avoid pests | Use of trap crops to trap and destroy pests | Weed control by machine cultivation, hoe or hand |
| Seed treatment with pesticides | Removal/pruning of diseased or heavily infested plants/tree branches | Purchase and release of predators or parasitoids to control major pests |
| Soil moisture testing | Planting parasite-attracting plants on field margins | Use of pheromone traps to reduce overall pest levels |
| Raised-bed production or mounding | Put baits and use other practices to encourage predator/parasite build-up | Use of pheromone inundation to confuse pest mating |
| Irrigation and drip irrigation | Use of pheromone traps to monitor pest levels | Spot treatment of pest hotspots with insecticides, miticides or fungicides |
| Use of natural fertilizers (manure, compost) | Inter-planting crops with aromatic herbs (celery, cilantro, parsley, dill or local plants) that repel pests | Area spraying (complete field coverage) using synthetic and natural insecticides, miticides or nematicides |
| Use of purchased mineral fertilizers (fertilizers are not regulated by 22CFR 216.3; note however that Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) are prohibited from USAID support) | Mulching with organic materials or plastic to control weeds | Use of synthetic and natural fungicides or bactericides |
| Combinations of organic and mineral fertilizers | Plant living barriers or bamboo/tree barriers on windward edge of field | Use of herbicides for weed control |
| Crop rotation | Exclude insect pests by using vegetable tunnels and micro-tunnels | Farm use of a locked storage building for pesticides |
| Use of green manure crops | Use of biodiversity or energy conservation practices | Farmer use of pesticide in-ground compost trap for depositing and capturing spilled or leftover pesticides |
| Farmer ability to correctly identify pests and their damage | Crop stalks, residue and dropped fruit destruction or composting at end of season | Farmer use of receptacle for empty pesticide bottle disposal |

# Annex 11: Farm and Project Record Keeping Associated with Pesticide Use

**CHEMICAL STOCK RECORD**

FARM NAME

TRADE NAME OF CHEMICAL

ACTIVE CHEMICAL INGREDIENTS

CONCENTRATIONS - %

PACKED   Kg / Lit

MANUFACTURER

REGISTRATION DETAILS

**PLEASE NOTE**

Only trained staff members allowed to issue and handle CHEMICALS

Inventory must be checked and updated at least once every week and documented

Please use one form per chemical type and packed weight

| Date | New Stock Delivered Litre / KG | Opening Stock Litre / KG | Stock Issued Litre / KG | Reason for Issue (Indicate Land Number and Product chemical will be applied to) | Closing Stock Litre / KG | Issued By (Name) | Signature | Received By (Name) | Signature | Empty Containers on Hand (Outers included) | Method of Disposal | Expiry Date | Disposed By (Name) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Approved by : A Hines | Chemical Stock Record - E 8.8.15, NC 1.13 Version 2 | Issue Date : 04 Oct 2007 Page 1 of 1 |
|---|---|---|

# CHEMICAL APPLICATION INSTRUCTIONS - JOVAC

| | | | |
|---|---|---|---|
| DATE | | PRODUCT | |
| LAND NUMBER | | BLOCK NUMBER | |

| CHEMI CHEMICAL PRODUCT(S) TO BE APPLIED | ACTUAL DOSAGE PER LAND | Water Vol. | Har. Int. day | Target | INSTRUCTIONS FOR APPLICATION |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| APPLICATION MACHINERY TO BE USED | | INSTRUCTION GIVEN BY (NAME) | SIGNATURE |
|---|---|---|---|
| | Foliar Application | | |

WHO EXECUTED THE INSTRUCTION

| NAME | | SIGNATURE | | Time of Spray | Start | Finish |
|---|---|---|---|---|---|---|
| | | | | | | |

SUITABLE AND CLEAN PROTECTIVE CLOTHING

SPECIAL INSTRUCTIONS WHEN HANDLING CHEMICALS

| Gloves | Boots | Raincoa | Overall | Nose/ Mouth | Respriator | Eye Pro. | Handling Dry Concentate | Handling Liquid Conc. | Water After Use | Keep Locked No Children | Chemical Are Dangero. |
|---|---|---|---|---|---|---|---|---|---|---|---|

PROTECTIVE CLOTHING ISSUED TO

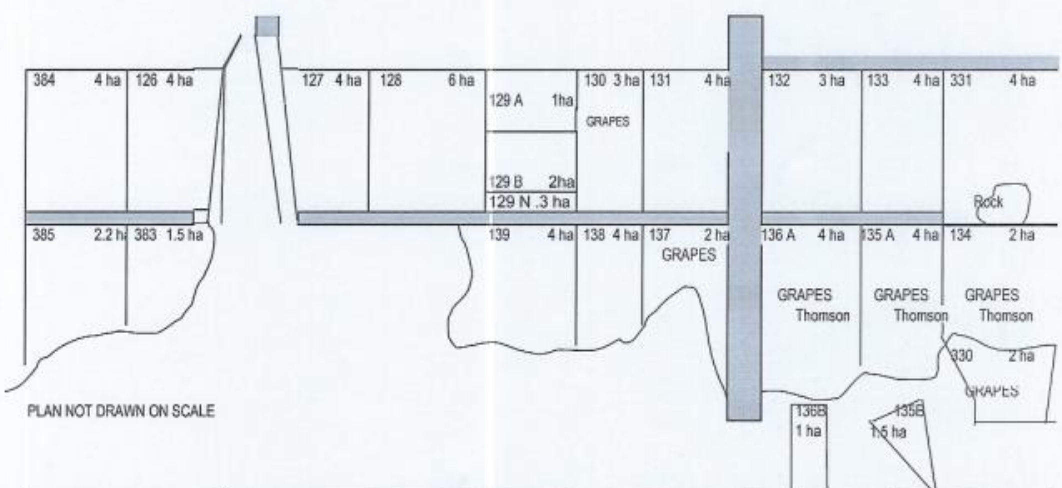
| | | | | | |
|---|---|---|---|---|---|
| Name | | Name | | Name | |
| Signature | | Signature | | Signature | |
| Name | | Name | | Name | |
| Signature | | Signature | | Signature | |

| WAS THERE EXCESS SPRAY MIX? | APPROXIMATE QUANTITY | WHAT HAVE YOU DONE WITH THE EXCESS SPRAY MIX? | EXECUTED BY (NAME) |
|---|---|---|---|
| YES / NO | Liters | | |

| Spray Washing | Lit of water | Location |
|---|---|---|
| YES / NO | | Washing Disposal Area |

Weather Conditions

| Rain | Dry | Clody | Tempture | Sunny | Wind |
|---|---|---|---|---|---|
| | | | | | YES / NO |




PLAN NOT DRAWN ON SCALE

| | | |
|---|---|---|
| Approved by: A .Hines<br>Pepared by: E .Nair | Chemical Application Instructions - E8.3.1-8.3.3, 8.3.5, 8.3.7-8.3.9, 8.6.2-8.6.3, 12.5.3, NC 1.10, 1.11<br>Version 9 | Issue Date: 20.4.06<br>Page 1 of 1 |

**1.- Control Card for Pesticides Use.-** This card will stay with farmer, to keep a record on the use of pesticide by crop.

Save the Children

***CONTROL FORM FOR THE USE OF PERTICIDES***

| GENERAL DATA | | | |
|---|---|---|---|
| **FARMERS NAME** | | | |
| **Community:** | **Municipality:** | **Province:** | **Altitude:** |
| **USE OF PESTICIDES - 1st TREATMENT** | | | |
| **CROP:** | | **SURFACE:** | |
| Pest to be treated | Name of material | Date and time of application | Quantity used |
| Environmental conditions: | | | |
| Justification for use | | | |
| Other recommended control measures | | | |
| Result of application | | | |
| **NAME AND SIGNATURE OF IG AND NRM SUPERVISOR:** | | | |
| **USE OF PESTICIDES - 2nd TREATMENT** | | | |
| **CROP:** | | **SURFACE:** | |
| Pest to be treated | Name of material | Date and time of application | Quantity used |
| Environmental conditions: | | | |
| Justification for use | | | |
| Other recommended control measures | | | |
| Result of application | | | |
| **NAME AND SIGNATURE OF IG AND NRM SUPERVISOR:** | | | |

## Annex 12: PERSUAP References

**Website references used to develop the PERSUAP**

International Treaties and Conventions:

POPs website: http://www.pops.int

PIC Website: http://www.pic.int

Basel Convention: http://www.basel.int/

Montreal Protocol: http://www.unep.org/OZONE/pdfs/Montreal-Protocol2000.pdf

Pakistan malaria poisonings: http://pdf.usaid.gov/pdf_docs/PNACQ047.pdf.

Pesticide poisonings:

http://www.panna.org/resources/panups/panup_20080403

http://magazine.panna.org/spring2006/inDepthGlobalPoisoning.html

IPM and PMP websites:

http://www.ipm.ucdavis.edu/

http://edis.ifas.ufl.edu/pg058

http://www.ipmcenters.org/pmsp/index.cfm

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/154769/Cotton-pest-management-guide-1.pdf

Pesticide Research Websites:

http://extoxnet.orst.edu/pips/ghindex.html (Extoxnet Oregon State database with ecotox)

http://www.agf.gov.bc.ca/pesticides/f_2.htm (all types of application equipment)

http://www.greenbook.net/Search/AdvancedSearch (pesticide Material Safety Data Sheets)

http://www.epa.gov/pesticides/reregistration/status.htm (EPA Registration Eligibility Decisions)

Ecotoxicity:

http://www.ohioline.osu.edu/hyg-fact/2000/2161.html (pesticide toxicity to honeybees)

http://wihort.uwex.edu/turf/Earthworms.htm (pesticide toxicity to earthworms)

Safety:

http://www.epa.gov/oppbppd1/biopesticides/ingredients/index.htm (EPA regulated biopesticides)

http://www.ipm.ucdavis.edu/index.html (IPM, PMPs and pesticide recommendations)

http://edis.ifas.ufl.edu/pdffiles/PI/PI07300.pdf (Restricted Use Pesticides) http://www.epa.gov/pesticides/health/ (EPA Health & Safety)

http://www.epa.gov/opppmsd1/PPISdata/index.html (EPA pesticide product information)

Personal Protection Equipment (PPE):

http://www.epa.gov/oppfead1/safety/workers/equip.htm (all types of PPE)

http://www.cdc.gov/nasd/docs/d001701-d001800/d001797/d001797.html (respiratory PPE)

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Hovmoller M S (2007). Climate change and plant diseases. Aarhus Univ. pp 6.

Economic Survey of Pakistan (2010-11). Finance Division, Government of Pakistan.

Khan A G (2004). Technical report on the characterization of the agro ecological context in which FAnGR (farm animal genetic resource) are found. International Livestock Research Institute (ILRI)/ National Agricultural Research Centre (NARC).

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PARC (2002). Policy and strategy for rational use of pesticides in Pakistan, UNDP/FAO, Global IPM Facility, Government of Pakistan

PARC (1980). Agro-ecological regions of Pakistan.

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Randhawa M A, F M Anjum, M R Asi, M S Butt, A Ahmad and M S Randhawa (2007). Removal of endosulfan residues from vegetables by household processing. Journal of Scientific and Industrial Research, 66 (10) 849-852.

Tahir M U, S I Naik, S Rehman and M. Shahzad (2009). A quantitative analysis for the toxic pesticide residues in marketed fruits and vegetables in Lahore, Pakistan. Biomedica, 25(2) 171-174.

Year Book 2009-10(2010). Ministry of Food and Agriculture Government of Pakistan.

Zia M S, M J Khan, M Qasim and A Rehman (2009) Pesticide residue in the food chain and human body inside Pakistan. Journal of chemical society of Pakistan. 31(2) 284-291.

## Annex 13: SOW for 2014 Pakistan Programmatic PERSUAP

**Agricultural Knowledge and Program Support Task Order**

**STATEMENT OF WORK – Programmatic PERSUAP for the Pakistan USAID Mission**

**WORK ASSIGNMENT: 13C**

**Statement of Work Number: 13C**

**Complete Title: Programmatic PERSUAP for the Pakistan USAID Mission**

**Short Title: Pak - PERSUAP**

**Begin Work Date:** 02/24/2014

**Approved:** ______________________________ (approval will authorize Weidemann to begin billable work on this work assignment based on the work plan incorporated herein.)

1. **PURPOSE**

This work is to provide a new Programmatic Pesticide Evaluation Report and Safe-Use Action Plan (PERSUAP) in order to ensure compliance with 22 CFR 216 pesticide procedures, to identify alternative and mitigating measures, to facilitate integrated pest management (IPM), and to address these issues for environmental and human health risk reduction. This will develop a new document that will replace the PERUSAP completed in November 2011 and recorded as OAPA-12-JAN-PAK-0015.

2. **BACKGROUND**

USAID and its implementation partners are obliged to follow the U.S. Government environmental regulations outlined in 22 CFR 216, USAID Environmental Procedures. These procedures include **Pesticide Procedures, as provided in §216.3 (b)(2) (see Attachment 1to this SOW) requiring all proposed projects involving assistance for the procurement or use, or both, of pesticides shall be subject to the procedures prescribed in §216.3(b)(l)(i) through (v). These procedures shall also apply, to the extent permitted by agreements entered into by A.I.D. before the effective date of these pesticide procedures, to such projects that have been authorized but for which pesticides have not been procured as of the effective date of these pesticides.** "Assistance for the procurement (including payment in kind, donations, guarantees of credit) or use (including handling, transport, fuel for transport, storage, mixing, loading, application, cleanup of spray equipment, and disposal) of pesticides or activities involving procurement, transport, use, storage, or disposal of toxic materials. Pesticides cover all insecticides, fungicides, rodenticides, etc. covered under FIFRA – 'Federal Insecticide, Fungicide, and Rodenticide Act' in various sectors, like agriculture, construction, health, water, etc. Pesticides are broadly defined in FIFRA Section 2(u) as chemicals and other products used to kill, repel, or control pests. ***Food Quality Protection Act of 1996*** (FPQA) (P.L. 104-170) further amends both the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA). It establishes a more consistent, protective regulatory scheme for pesticides, mandating a single health-based standard for all pesticides in foods, in addition to advancing other protective provisions. Attached to this SOW is the complete approval memorandum from the Office of Afghanistan and Pakistan Affairs (OAPA) Bureau Environmental Officer (BEO) with the summary of the approval of the present PERSUAP that will serve as the model for the one called for in this work assignment.

## 3. OBJECTIVES

Develop a current Programmatic Pesticide Evaluation Report and Safe-Use Action Plan (PERSUAP) in order to ensure compliance with 22 CFR 216 pesticide procedures, to identify alternative and mitigating measures, to facilitate integrated pest management (IPM), and to address these issues for environmental and human health risk reduction per 216.3 (b) (2) procedures was last prepared in November 2011. The Mission has an approved Programmatic PERSUAP (BEO tracker # OAPA-12-JAN-PAK-0015, approved on January 1, 2012). This Programmatic PERSUAP is required to be renewed every two years to insure that the PERSUAP reflects up to date pesticide applicability as well as provides current use practices.

## 4. PHASES

Two primary phases has been defied for this work assignment with correlating tasks.

- **Phase I -** Phase I will focus on PERSUAP data review, collection and analysis resulting in a first draft of a Programmatic PERSUAP for the USAID/Pakistan Mission.
- **Phase II** – Phase II will comprise of amending the first draft of the PERSUAP according to comments and guidance received from USAID and provide a final recommendations for future PERSUAP activities and draft of the required approval memorandum for the PERSUAP.

## 5. TASKS

Phase I Tasks -Data Review, Collection and Analysis: Location: Islamabad, Pakistan with travel to other areas of Pakistan. Note: travel throughout Pakistan may be required. Expatriate is not expected to work in Pakistan.

1. Review the current IEEs, Mission 2011 U-PERSUAP and 2013 U-PERSUAP Update, and other documents relating to potential use of pesticides, and Agency's best practice with "Programmatic PERSUAPs," e.g. the ones prepared for USAID-funded activities in Kyrgyzstan and Tajikistan, and other locations throughout the World.

2. Prepare an outline with Table of Contents (TOC) and outline for a Programmatic PERSUAP document to be approved by the Pakistan mission project COTR, MEO and concurred by the BEO//OAPA and REA/OAPA-ASIA of USAID. This should include a short (one to two paragraphs) description of what would be contained in each section.

3. Present for USAID approval a work plan for the PERSUAP development within 5 work days after the start of the work plan.

4. Prepare and present for USAID approval, a questionnaire to Mission's staff and implementers regarding on-going and ALL planned sectoral activities with potential use of pesticides.

5. Identify natural resources (water, soil, air) and biodiversity (sensitive areas and parks, rare species, natural bodies of water) that may be at risk from pesticide use, and identify measures to mitigate risks.

6. Visit and evaluate PERSUAP implementation challenges with provincial and national policymakers, pesticide importers, distributors and stores (sales systems), pesticide storage

systems, pesticide use systems, pesticide labeling, transport and cleanup, and pesticide/container disposal systems.

7. Identify environment and safety standard linkages to certification and trade issues related to agriculture produce processing such as ISO 14000 and Hazardous Analysis Cortical Control Point (HACCP).

8. Evaluate challenges in required compliance of USAID Pakistan programs with USAID Pesticide Procedures and with the national environmental, pesticide and pest management policies and monitoring programs, and identify needed remedial action a sustainability standpoint.

9. Review the USAID programs and document potential PERSUAP related activities; and consult with technical office project technical staff on potential environmental and health risk issues, types of activities, and pesticide use within the project.

10. Analyze data and write the first draft of a Programmatic PERSUAP for the USAID/Pakistan Mission based upon the results of work done, and submit for USAID review along with a communication protocol for Mission review and approval of the PERSUAP.

11. Assist USAID Project implementation and host country partners to modify or include actions in their programs that will achieve compliance with health and environment standards; indicate pesticides that cannot be used, those that can be used with specialized training but phased out, and those that may be used; and significantly reduce pesticide risks.

12. Review, and make suggestions as needed on improving existing system, the Mission's system for using completed and signed-off work plans and other monitoring tools/questionnaires to check compliance. This system includes the IEEs, EDF, EMMPs, and the Environmental Compliance Data Base kept in the Mission.

13. Review & distill lessons learned from implementation of the original PPERSUAP and its Update by relevant projects & whether PPERSUAP & UPDATE was translated into local languages.

14. Provide a phased system for training on pesticide safety and integrated pest management, including training on 22 CFR 216 compliance and the PERSUAP process, as well as on certification (Global GAP, Organic, Fair Trade) and trade issues that can be implemented by the Mission in consultation with the MEO.

15. Conduct any other activities necessary to assist USAID/Pakistan's compliance with relevant USAID and national environmental regulations.

Phase II Tasks -Report and PERSUAP development: These tasks will be performed by the expatriate consultant only.

1. Amend the first draft of the PERSUAP according to comments and guidance received from USAID after their review of the draft Programmatic PERSUAP

2. Develop a draft memo (cover letter) for approval of the PERSUAP to be sent to the BEO. Examples of these are included in the most recent approvals of the Mission PERSUAPs.
3. Provide recommendations and a draft Scope of Work for a follow-up visit (s) to review environmental compliance work plans in relation to an approved PERSUAP; monitor implementation and compliance with the PERSUAP; and provide supplementary training on environmental issues and compliance.

## 6. TEAM

The team will consist of the following positions: Expatriate Pesticide Expert and a Pakistani National Pesticide Expert. The Team will be led by the Expatriate Pesticides Expert. Position qualifications are as follows:

- Expatriate Pesticide Expert: We propose Dr. Alan Schroeder, who performed four of the past five PERSUAPs for Pakistan (2007 for I-LED, 2009 for FATA-LDP, Programmatic PERSUAP 2011, and Annual Update of Programmatic 2012-13), to support this assignment remotely as the Expatriate Pesticide Expert. Dr. Schroeder has researched and written over 25 PERSUAPs for several regions served by USAID. Most notably he has researched and written six PERSUAPs for Afghanistan from 2005 to 2011 and just finished writing the Programmatic PERSUAPs for Tajikistan and Kyrgyzstan in 2011. Dr. Schroeder has an advanced degree in Agriculture specializing in pest management and over 10 years of relevant experience in preparing safe use plans for pesticides in international donor supported programs. He has knowledge of US Environmental Protection Agency and USDA rules and regulations on the use of pesticides. Dr. Schroeder understands US rules and requirement for pesticide registration and has experience in designing safe use pesticide action plans following the requirements of 22 CFR 216 (Please see Annex A for Dr. Schroeder's CV).

- Pakistani National Pesticide Expert (PNPE): We propose Dr. Muhammad Aslam, a Pakistani National Pesticide Expert with an advanced degree in agriculture and over 20 years of experience in pest management and agriculture in Pakistan. (See his full CV attached in Annex A.) He will function as the principal contact and resource person to identify relevant Pakistani laws, regulations, and common practices on pesticide use and management. His responsibilities will include working with principal government officials that control and monitor pesticide use as well as accessing and interviewing contacts among the commercial venders that supply pesticides.

## 7. APPROACH

The Expatriate Pesticide Expert will work on this project remotely and be supported by the Pakistani National Pesticide Expert (PNPE) on the ground, who will collect needed information and knowledge and any necessary interviews for the assignment. Dr. Schroeder has a strong record of success in working in this manner with all of the PERSUAPs he performed for Afghanistan and Pakistan being carried out virtually, without travel and with the assistance of highly qualified local experts, who collected information and shared insights to support Dr. Schroeder researched, final PERSUAP report and training documents.

## 8. ESTIMATED LEVEL OF EFFORT

The total estimated level of effort for this works assignment is 80 consulting days plus 12 technical and administrative support days. The Expatriate Pesticide Expert's (EPE) estimated Level of Effort is a total of 50 days. 40 days for Tasks A and 10 days for Tasks B.

The Pakistani National Pesticide Use Expert's (PNPE) estimated Level of Effort is a total of 30 days to work with the Expatriate Pesticide Expert and coordinate efforts to meet Task A deliverables.

## 9. PERIOD OF PERFORMANCE

The proposed period of performance is from February 24th, 2014 until May 5th, 2014 as follows:

- Phase I - begins February 24th, 2014 and ends April 18th, 2014

| Location | Date | Activities |
|---|---|---|
| EPE in Washington<br><br>and<br><br>PNPE in Pakistan | Week 1<br><br>February 24th to February 28th | Work Assignment approved by February 13th.<br><br>EPE will review the current IEEs, 3 Mission PERSUAPS, and other documents relating to potential use of pesticides, and Agency's best practice with "Programmatic PERSUAPs," e.g. the ones prepared for USAID-funded activities in Kyrgyzstan and Tajikistan, and other locations throughout the World.<br><br>Present for USAID approval a work plan for the PERSUAP development within 5 work days after the start of the work plan.<br><br>PNPE will collect and send to EPE currant Pakistan pesticide regulations, environmental regulations, the list of registered pesticides, and a list of major pests of each target crop.<br><br>Deliverable 1 (day 5 after agreement signing): Technical Approach and an outline for a programmatic PERSUAP with succinct Table of Contents (TOC) and appendices. |
| EPE in Washington<br><br>and<br><br>PNPE in Pakistan | Weeks 2 and 3<br><br>March 3rd to March 14th | EPE will prepare and present for USAID approval, a questionnaire to Mission's staff and implementers regarding on-going and ALL planned sectoral activities with potential use of pesticides.<br><br>PNPE will collect and send to EPE a list of unregistered (from informal or illegal markets) pesticides found in bazaars, shops or stores near project sites.<br><br>PNPE will interview key stakeholders (project technical staff, pesticide store owners, government officials, and farmers) and conduct internet research to collect information needed for the 12 Regulation 216 pesticide factors A to L.<br><br>PNPE and EPE will identify natural resources (water, soil, air) and biodiversity (sensitive areas and parks, rare species, natural bodies of water) that may be at risk from pesticide use, and identify measures to mitigate risks.<br><br>PNPE will visit and evaluate PERSUAP implementation challenges with provincial and national policymakers, pesticide importers, distributors and stores (sales systems), pesticide |

| | | |
|---|---|---|
| | | storage systems, pesticide use systems, pesticide labeling, transport and cleanup, and pesticide/container disposal systems.<br><br>EPE will identify environment and safety standard linkages to certification and trade issues related to agriculture produce processing such as ISO 14000 and Hazardous Analysis Cortical Control Point (HACCP).<br><br>EPE and PNPE will evaluate challenges in required compliance of USAID Pakistan programs with USAID Pesticide Procedures and with the national environmental, pesticide and pest management policies and monitoring programs, and identify needed remedial action a sustainability standpoint.<br><br>EPE will analyze all pesticide active ingredients for pesticide class (to be able to rotate pesticides), Pakistan and EPA registrations (for compliance), EU registration (for trade), Restricted Use Pesticide (RUP) status (for compliance), WHO and EPA acute human toxicity classifications (for safety), chronic human health issues (for safety), water pollution potential, terrestrial ecotoxicity (to honeybees, birds, earthworms) and aquatic toxicity (fish, amphibians, crustaceans, mollusks, aquatic insects and plankton, as available.<br><br>EPE delivers a list of all pesticide active ingredients analyzed by the above factors. |
| EPE in Washington<br><br>and<br><br>PNPE in Pakistan | Weeks 4, 5, 6 and 7<br><br>March 17$^{th}$ to April 11$^{th}$ | PNPE and EPE develop a system for using completed and signed-off work plans and other monitoring tools/questionnaires to check compliance.<br><br>PNPE with guidance from EPE, will collect and review & distill lessons learned from implementation of the original PPERSUAP and its Update by relevant projects & whether PPERSUAP & UPDATE was translated into local languages.<br><br>PNPE, with guidance from EPE, provide a phased system for training on pesticide safety and integrated pest management, including training on 22 CFR 216 compliance, if needed or desired for trade, EU compliance and the PERSUAP process, as well as on certification (Global GAP, Organic, Fair Trade) and trade issues that can be implemented by the Mission in consultation with the MEO.<br><br>EPE and PNPE conduct any other activities necessary to assist USAID/Pakistan's compliance with relevant USAID and national environmental regulations.<br><br>EPE, with PNPE assistance, will analyze all crops for best practices, all major pests (insects, mites, nematodes, mollusks/snails, fungal diseases, bacterial diseases, viral diseases, other diseases, rodents and birds) of each crop, as |

| | | |
|---|---|---|
| | | available, and all recommended IPM measures to research and adopt locally. IPM measures covered will include non-chemical and chemical tools and tactics. Chemicals will be divided into natural and synthetic pesticides commercially-available.<br><br>EPE delivers the crop-pest-IPM-pesticide analyses. |
| EPE in Washington and<br><br>WAI home offices | Week 8<br><br>April 14th -18th | EPE, with PNPE assistance, will analyze data and write the first draft of a Programmatic PERSUAP for the USAID/Pakistan Mission based upon the results of work done, and submit for USAID review along with a communication protocol for Mission review and approval of the PERSUAP.<br><br>EPE delivers a Draft PERSUAP document with all required analyses, references and tools attached. Tools and guidance include: Recommendations for training on the procurement and/or use according to USAID approved PERSUAP to USAID COTRs, contractor teams, stakeholders, federal and provincial government agencies, academia and other relevant stakeholders; Assistance to the Mission with drafting of a Mission Notice/Mission Order on the procurement and/or use of pesticides and implementation of the PERSUAP requirements; and Recommendations and a draft Scope of Work for a follow-up visit(s) to review environmental compliance work plans in relation to the approved PERSUAP, monitoring of implementation and compliance with the PERSUAP, and to provide supplementary training on new environmental issues, challenges and compliance.<br><br>The Weidemann team finalizes Phase 1 deliverables. Final copies of Phase 1 deliverables delivered to USAID Pakistan Mission by Start of Business, April 13th. |

- Phase II - begins April 20th, 2014 and ends May 5th, 2014.

| **Location** | **Date** | **Activities** |
|---|---|---|
| EPE in Washington and<br><br>WAI home office | Week 9<br><br>April 21st – 24th | EPE reviews and responds to suggestions from COR, MEO, REA. |
| EPE in Washington and<br><br>WAI home office | Week 10-11<br><br>April 28st – May 5nd | EPE reviews and responds to suggestions from BEO and all remaining issues.<br><br>The Weidemann team finalizes Phase II deliverables. Final copies of Phase II deliverables delivered to USAID Pakistan Mission. |

It is understood that the following are our principle contacts at the Mission and OAPA Office:

- Mission Environmental Officer and Deputy MEOs
- Mission Health Officer
- Mission Program Officer
- Technical Officer Directors
- Regional Environmental Adviser/Asia & OAPA based in Almaty, and OAPA/ BEO based in Washington, DC.

### 10. DELIVERABLES

**Deliverable 1:** Technical Approach for the development of a new programmatic PERSUAP including a work plan, a written description/summary of the deliverables, and a planned date of completion for the work.

**Deliverable 2:** A review of the existing programmatic PERSUAP and any updates and presentation of the USAID approved approach and outline covering pesticides recommended for use in USAID/Pakistan funded or co-funded activities in all sectors during the next three to five years.

**Deliverable 3:** Recommendations for removal or modification on existing recommendations in the PERSUAP.

**Deliverable 4:** Identification of new pesticides that could be used that were not included in the previous updated PERSUAP

**Deliverable 5:** A new Programmatic PERSUAP that that incorporates the required changes.

**Deliverable 6:** Recommendations and design for training on the procurement and/or use according to USAID approved PERSUAP to USAID COTRs, contractor teams, stakeholders, federal and provincial government agencies, academia and other relevant stakeholders.

**Deliverable 7:** Assistance to the Mission with drafting of a Pakistan Programmatic PERSUAP Approval Cover Letter.

**Deliverable 5:** Recommendations and a draft Scope of Work for a follow-up visit(s) to review environmental compliance work plans in relation to the approved PERSUAP, monitoring of implementation and compliance with the PERSUAP, and to provide supplementary training on new environmental issues, challenges and compliance.

# Annex 14: USAID/Pakistan IEEs, Fumigation PEA, EAs & PERSUAPs

## Agriculture (Horticulture and Livestock) IEEs

### FIRMS Project (2009-2015)

According to the USAID Gemini Environmental Compliance search tool, ASIA 10-226 Pakistan IEE & ETD Pakistan Firms Project shows a negative determination with conditions for the use of pesticides. The FIRMS Project IEE has been extended by amendments twice to March 31, 2015. Its purpose is to promote, accelerate and expand economic opportunities by creating domestic and export market-driven sales opportunities for private businesses that will expand the number of available jobs in vulnerable districts of Pakistan and in other districts where project actions support such opportunities in vulnerable districts

### The Agribusiness Project (2011-2015)

The five-year, $90 million Pakistan Agribusiness Project (Pakistan AP, previously known as AVC), funded by USAID-Pakistan, strengthens local capacity within key value chains to increase sales in domestic and foreign markets. The program increases economic growth, creates employment opportunities and amplifies the competitiveness of horticulture and livestock value chains. Pakistan AP also increases effectiveness of smallholder enterprises, enhances agriculture productivity, and is the first USAID economic growth program to be led by a Pakistani organization – the Agribusiness Support Fund (ASF). As ASF's stateside partner, CNFA's role is to assist ASF in strengthening grant management, accounting, reporting, monitoring and evaluation, environmental, and information management systems and procedures, as well as to provide technical assistance for development of horticulture and livestock value chains.

While the original Pakistan U-PERSUAP was written in 2011, an IEE (OAPA-11-MAY-PAK-0026) was drafted to cover a large 5-year agriculture project, originally named Strengthening Agriculture Value Chains (AVC) and budgeted at $240 million. It provided a Positive Threshold Determination (PTD) recommending that a PEA be produced, and mentioned the 2013 U-PERSUAP Update that would cover pesticide activities in this AVC project, as well as others.

Later, in 2012, that AVC IEE was amended to change the project name to USAID's Agribusiness Project (UAP), wisely reduced the budget to $89.412 million, and changed the scope of some activities. More importantly, the amended IEE recommended changing the PEA requirement to just an EA requirement. During the scoping exercise for that EA, pieces of the 2013 U-PERSUAP relating to disinfectants and termiticides were used to inform decisions on activities for elimination or further environmental review. The scoping exercise team ultimately found that the UAP activities qualified as sufficiently small scale, likely resulting in sufficiently small risks, and the Scoping Statement (SS) did not recommend that an EA be pursued. It did recommend that the 2013 U-PERSUAP continue to be consulted, updated and used. The project was later named The Agriculture Project (TAP).

### Policy, Science and Innovation Program in Agriculture

A 2011 request for a CE (OAPA-APR-PAK-0022) was made to cover technical outreach on media campaigns, Office of Foreign Disaster Assistance (OFDA)/National Disaster Management Authority (NDMA) activities and a $73 million dollar program titled Policy, Science and Innovation Program in Agriculture for policy, capacity building and research with CGIAR (Consultative Group for International Agriculture Research) centers.

### FATA Program

A 2011 IEE amendment 3 (OAPA-11-SEP-PAK-0040) that could involve pesticides for the FATA program correctly references the 2009 FATA PERSUAP. The 2011/2013 U-PERSUAP/Update further updates this pesticide information. A 2013 IEE amendment 4 (OAPA-13-DEC-PAK-0004) for FATA the TD (Threshold Determination) for infrastructure and construction was changed from PTD to ND/C.

2009-2015 Balochistan Agriculture Project: The project helps communities and individual farmers to increase the production, sales, and revenues for crops and livestock. Activities include new technologies and practices, improved management approaches, new varieties of crops and livestock, as well as better water management techniques. To introduce these new approaches, the project helps set up and train community organizations, mutual marketing organizations, and farmers marketing collectives.

No IEE found on Gemini Project.

2012-2015 Conflict Victims Support program: The program aims to provide equitable and transparent support to civilian victims of conflict related violence in the KPK and FATA. Designed assistance packages should take into consideration medical, psycho-social, livelihood and long-term support needs of civilian victims ensuring the maximum service-delivery to the beneficiaries. Agriculture development falls under livelihoods. No IEE found on Gemini.

2011-2014 Dairy Development project: The Dairy Project is a joint effort of United States Agency for International Development (USAID) and Dairy and Rural Development Foundation (DRDF) to foster sustainable increase in dairy and livestock productivity through adoption of best farming practices, breed improvement, availability of timely extension services, and promotion of livestock businesses. Due to the vital importance of livestock sector in the rural economy of Pakistan, the Dairy Project's extensive training programs for dairy farmers, women livestock extension workers, and artificial insemination technicians will play an important role in transforming livelihoods of rural communities. No IEE found on Gemini.

### Food Security IEEs and 2013 Fumigation PEA

A July 2010 UNWFP program IEE amendment 5 (Asia 10-128, no further tracking number provided) with recommended environmental actions of a CE for provision of food and a ND for monitoring WFP contracted activities including transport, distribution and storage. This IEE amendment makes no mention of highly toxic aluminum phosphide used for treating stored food products, by WFP, contracted warehouse owners or beneficiaries, and the need for a PTD (Positive Threshold Decision) or PERSUAP. The 2011 U-PERSUAP and 2013 U-PERSUAP Update cover fumigation.

A 2012 IEE amendment 6 (OAPA-13-OCT-PAK-0001) for the UNWFP adds funds. It also recommends that the 2011 U-PERSUAP be referenced and used for any activities involving pesticides.

A 2013 IEE amendment 7 (OAPA-13-MAR-PAK-0009) extends the LOP for the UNWFP activities to cover Flood-Affected Families in Sindh and Balochistan Provinces.

In 2013, USAID's DCHA released a Fumigation PEA for use of highly toxic aluminum phosphide and phosphine gas to treat stored grain and food. This PEA compares all methods of grain/food treatment and fumigation and provides risk mitigation measures for dealing with aluminum phosphide/phosphine gas. The following are essential measures to ensure safety:

Fumigation (**absolutely requires two trained and certified-level fumigators for each fumigation event**):

- In the USA, “persons who are not trained and certified for the use of grain fumigants must not attempt to fumigate stored grain”
- Follow the aluminum phosphide label to determine correct amount of chemical to use per cubic meter of infested food commodity
- Calm warm day with no wind and temperature above 16 degrees (and not less than 4 degrees) Celsius
- Learn & follow all safety regulations
- Have ***two trained people*** present for safety
- Plan to finish fumigation in 15-20 minutes maximum
- Post warning signs on all doors
- Use tape and 4 ml polyethylene sheeting
- Leave only necessary holes for putting aluminum phosphide tablets or gas from gas generator and quickly sealing them
- If using tablets, use probes to put tablets around (not in) grain sacks and pallets
- Remove webbing if Indian meal moth larvae are present
- Use proper respiratory protection equipment for ***both fumigators***
- Use phosphine gas detection devices
- *Absolutely no phosphine tablets or residues come into direct contact with wheat flour*

Need respiratory breathing protection for mouth/nose:

- Canister gas masks for phosphene concentrations of 0.3-15 ppm
- Self-contained breathing apparatus (SCBA) for phosphene concentrations above 15 ppm
- Both canister and SCBA available to be ready for any phosphine concentration
- Phosphine meters present to **continually monitor** phosphine concentration while fumigating
- Fumigators must measure concentration of phosphine to determine proper protective equipment
- One fumigator puts the tablets or gas, and the other seals the plastic & **continuously** monitors phosphine levels
- Passive phosphine detection devices can also be worn by applicators

Factors that contribute to less than 100% pest control

- Poor gas distribution
- Unfavorable treatment conditions
- Leaks
- Fines (grain dust)
- Type of pest (resistance is present)
- Grain temperature
- Presence of high amounts of insect eggs—a difficult stage to manage

Primarily the Fumigation PEA also provides a long list of preventive measures that can be used to minimize the amount and use of aluminum phosphide. These include the following preventive Integrated Pest Management and storage/warehouse sector best practices, which should be followed by any project that deals with grain/food storage pests:

Integrated Pest Management for stored grain pests includes:

- Harvest seeds and grains on time as soon as ripe and sufficiently dry
- Sun-drying some seeds and grains before storage reduce beetle infestation

- Sanitation/Cleaning all surfaces of spilled seeds/grains and residues (vigilance must be maintained to clean all surfaces well including windowsills, ledges, and pallets)
- Strictly adhere to the first in first out (FIFO) rule
- All seed/grain stored in bags on pallets away from walls
- Close/screen all entry points used by rodents and birds
- Manage weeds around warehouse to reduce rodents
- Provisions and use of Triple Bagging Technology[86]
- Good ventilation and aeration of commodities
- Positive pest identification is important
- Knowledge of pest biology, ecology, and behavior
- Routine monitoring is first & foremost

### Avian Influenza IEEs

No IEEs have been writing covering Avian Influenza in the past 6 years.

### Health: Mosquito-Borne Diseases IEEs

No IEEs have been found written specifically covering Mosquito-Borne Diseases in the past 6 years. Two historic PEAs continue to cover USAID activities related to both malarial mosquito spraying and bed nets.

A 2012 IEE amendment 3 (OAPA-12-MAR-PAK-0019) for the Infectious Disease Prevention and Control Program, with both a CE and ND/C does not mention malaria or dengue. It also does not mention the 2011 U-PERSUAP.

Another 2012 IEE amendment 4 (AOPA-12-JUL-PAK-0031) for the Infectious Disease Prevention and Control Program, with both a CE for training, capacity building, investigations and M&E and a ND/C for medical equipment including disinfectants (microbiocides), construction, water and sanitation, with no insecticides for vector control. Although the IEE amendment omits discussing necessary termiticides for construction and the fact that disinfectants are microbiocides that fall under the category of pesticides, it does reference the 2011 U-PERSUAP and recommendations therein for any future activities that may require them.

### Construction and Water/Sanitation Sectors IEEs

2007-2017 Satpara Development Project: OAPA 14 NOV PAK 0005 renames the Satpara Dam Project to the Satpara Development Project and adds agricultural development with irrigation canals.

2011-2016 Sindh Basic Education Program (SBEP): OAPA-13-JAN-PAK-0006. Provides basic education and infrastructure construction. Pesticide use for construction must conform to PERSUAP.

2012-2017 Municipal Services Program: OAPA-13-SEP-PAK-0023. Construction pesticides will follow PERSUAP recommendations. Municipal Services Development Program (MSDP) plans to take a systemic approach to reform. Since the Khyber Pakhtunkhawa province represents complex social systems that include multiple centers of power with considerable autonomy and resources at their disposal, it is essential to recognize that an institutional transformation is required to put in place a fundamental reform that will affect municipal service delivery, that can be implemented and that will

[86] http://extension.entm.purdue.edu/publications/E-263.pdf

endure. The goal of MSDP is sustained improvement in municipal service delivery to better address the basic needs of citizens located in three urban areas of Khyber Pakhtunkhwa.

2006-2014 Pakistan Reconstruction Program: OAPA-12-FEB-PAK-0018. Construction pesticides will follow PERSUAP recommendations. The construction of buildings after earthquake. Construction of Ten Faculty of Education Complexes in Pakistan.

A 2008 IEE amendment 1 (ANE 08-129, no further tracking number provided) for SO 391-004 PDGP with a ND/C to a 2006 IEE covering small scale construction did not mention the need for a PERSUAP to cover termite and other required construction pesticide treatments. A 2011 amendment of this IEE (OAPA-11-JUL-PAK-0032) has only the cover page and is missing the remaining needed pages in the USAID Gemini database.

A 2010 IEE (ANE 11-11, no further tracking number provided) for Satpara Dam delivers a ND/C with the limitation that this assistance does not include the procurement, use or recommendation of pesticides, while making no mention of a PERSUAP for required construction termiticides, irrigation water quality and water treatment chemicals, instead referring to local and WHO regulations and mitigation as a compliance umbrella for its activities.

A 2010 IEE (ANE 10-12, no further tracking number provided) for Gomal Zam Dam delivers a ND/C with the limitation that this assistance does not include the procurement, use or recommendation of pesticides, while making no mention of a PERSUAP for required construction and electric transmission (by treated wood poles) termiticides, irrigation water quality and water treatment chemicals, instead referring to local regulations and mitigation as a compliance umbrella for its activities.

### SSs/EAs

Although the original 2011 TAP (UAP/AVC) project SS recommended against the production of an EA due to the small scale of activities, another 2013 SS (OAPA-13-FEB-PAK-0007) was written recommending that an EA be produced. The SS, on page 30, refers to the 2011 U-PERSUAP for guidance on pesticide use; however it mentions that the PERSUAP covers "all horticulture, flower, fish and livestock crops". It does not cover "fish 'crops'".

An IEE (OAPA-11-JUN-PAK-0011) recommended an EA (OAPA-12-OCT-PAK-0006) for Gomal Zam Irrigation System Development. It was produced, and a PERSUAP was not mentioned in it.

### PERSUAPs

In 2007, a PERSUAP was drafted for the Improving Livelihoods and Enterprise Development (I-LED) Program for earthquake-affected parts of Pakistan, including Siran and Kaghan Valleys located in the North West Frontier Province (NWFP) and Bagh District located in Azad Jammu Kashmir (AJK). I-LED linked crop production in these areas to markets with economic growth potential. One part of I-LED focused on the sustaining and increasing production of basic grains, vegetables, oil and fiber crops, fruits and nuts. Access to agriculture inputs, especially pesticides, was considered essential. The PERSUAP analyzed all of the target crops, pests and all pesticides registered in 2007 by the Government of Pakistan (GOP). At that time, numerous highly toxic, Class I chemicals were still registered by Pakistan for import and use. This included azinphos-methyl, carbofuran, dichlorvos, and endosulfan, in addition to banned pesticides entering Pakistan illegally. In 2007, IPM information from the region was sketchy and very basic IPM practices were recommended for various crop-pest combinations.

In 2009, a PERSUAP was drafted for the Pakistan Livelihood Development Program for the FATA-LDP project. It covered organizations to develop consortiums, alliances and partnerships to implement a social and economic stabilization and development program impacting the seven Agencies of FATA and the six bordering Frontier Regions. One component of LDP was community-based programs comprised developing new farm service centers and other sustainable businesses, including agriculture production, processing to add value and marketing.

The FATA-LDP Program and PERSUAP covered basic grains, vegetables, oil crops, fruits and nuts grown in FATA as well as pesticides registered in Pakistan in 2009. At the time, IPM information from the region was sketchy and very basic IPM practices, excluding pesticides, were recommended for various crop-pest combinations. From 2007 to 2009, the number of highly toxic and banned pesticides entering Pakistan declined, due more likely to lack of international markets and thus lack of banned pesticide manufacturers than to increasing control by GOP. Endosulfan, produced primarily in quantity in India, continued to be imported in large quantities and used in Pakistan on cotton and other commercial crops.

The original 2011 Pakistan U-PERSUAP (AOPA-12-JAN-PAK-0015) reviewed all pesticides and chemicals registered at the time for procurement and use in Pakistan, and analyzed major crops, pests, IPM and pesticide tools. Additional IEEs and EAs for agriculture, water and sanitation, avian influenza disinfection, construction and perhaps future malaria projects will reference this 2013 PERSUAP update and follow its recommendations.

In the immediate region, both Tajikistan and Kyrgyzstan had U-PERSUAPs written in 2011 to cover the same sectors (as in Pakistan) in their countries. And, in 2013, the USAID mission to Afghanistan was working to produce an Programmatic PERSUAP to cover their activities as well, but it was unclear if non-agriculture sectors would be included. Other USAID regions, such as Africa, were also considering using this Umbrella or Programmatic PERSUAP approach.

# Annex 15: Recent History of Integrated Pest Management and Food Safety in Pakistan

## Background

Prior to the mid-2000s, 70-80% of pesticides in Pakistan were used only for the control of insect pests and diseases of cotton with the rest on other crops, vegetables and fruits. Now, the amount used on cotton has been reduced to less than 60% (Agri. Statistics of Pakistan 2009-10). Pakistan is one of the leading countries of the world where excessive amounts of pesticides were used to manage crop pests. Misuse of pesticides played role in disturbing agroecological systems, elimination of natural pest enemies, pest outbreaks, resurgence and resistance in pests, increased pesticide residues in food, contamination of soil and water, direct impact on human health (farmers, applicators, sellers & consumers), extinction of wild life, farmers' profits declining, environment and biodiversity. Pesticide causes poisoning of thousands of people every year where pesticides applicator and women workers are mostly affected. Adopting an IPM approach can arrest this trend.

## Fao's Farmer Field Schools (FFS) Based IPM Approach

FAO's FFS approach was originally planned as a way to introduce knowledge of IPM to farmers in Asia. Initiated by FAO with USAID funding in the Philippines and Indonesia in the late 1980s to rationalize rice pest prevention and management, the IPM-FFS experiences of these two countries have since been used to promote and enlarge FFS activities to other parts of Asia as well as Africa.

The Pakistan Agriculture Research Council (PARC) undertook research and development of IPM in 1971. To control Cotton Leaf Curl Virus, a program was initiated in 1995 with the assistance of Asian Development Bank (ADB). CABI Bioscience Pakistan Centre conducted a pilot study and tested suitability of Training of Trainer TOT / FFS approach for IPM implementation in Punjab Province. The key to this IPM strategy was the conservation of natural enemies to reduce or replace reliance on chemical pesticides. This proved that it is quite possible to reduce insecticide applications at least 50% from 6 to 2 sprays per season under IPM decision-making, while obtaining the same or slightly higher yields and about 20% higher economic returns to the IPM Farmers.

## Establishment Of National IPM Programme In Pakistan

IPM activities advanced quickly during the 2000s through governmental support and donor cooperation to reduce the misuse of pesticides and their negative impacts on ecosystem for sustainable agricultural development. Starting in 2000, after discussions with potential stakeholders, the Government of Pakistan, MINFAL established a National Integrated Pest Management Programme (NAT-IPM) at NARC, part of PARC

The National IPM Programme has completed a project entitled "Policy and Strategy on Rational Use of Pesticides in Pakistan". Subsequently, the National IPM Programme with the support of FAO-EU successfully completed a project on cotton IPM in Asia and the FAO-ADB Cotton IPM TA for Pakistan and FAO-AGFUND pilot project on "Pesticide Risk Reduction to Women". The National IPM Programme also undertook a Public Sector Development Programme funded National Integrated Pest Management Project from 2004 -2010. The project was taken as continuation of IPM-FFS activities with the main objective of large scale and sustainable implementation of IPM in Pakistan, rationalizing the use of pesticides while maintaining production levels and increasing farmer's profit.

## Implementation Strategy

The world experience has shown that the best technique for the translation of knowledge is through TOF/T and FFS activities. Under this approach actions are not pre-planned and are not top down but are based on the analysis of agro-ecosystem and site specific and beneficiaries make decisions, with the help of facilitators. The use of TOF and FFS has been verified as an effective and participatory approach and mean of dissemination of IPM in Pakistan.

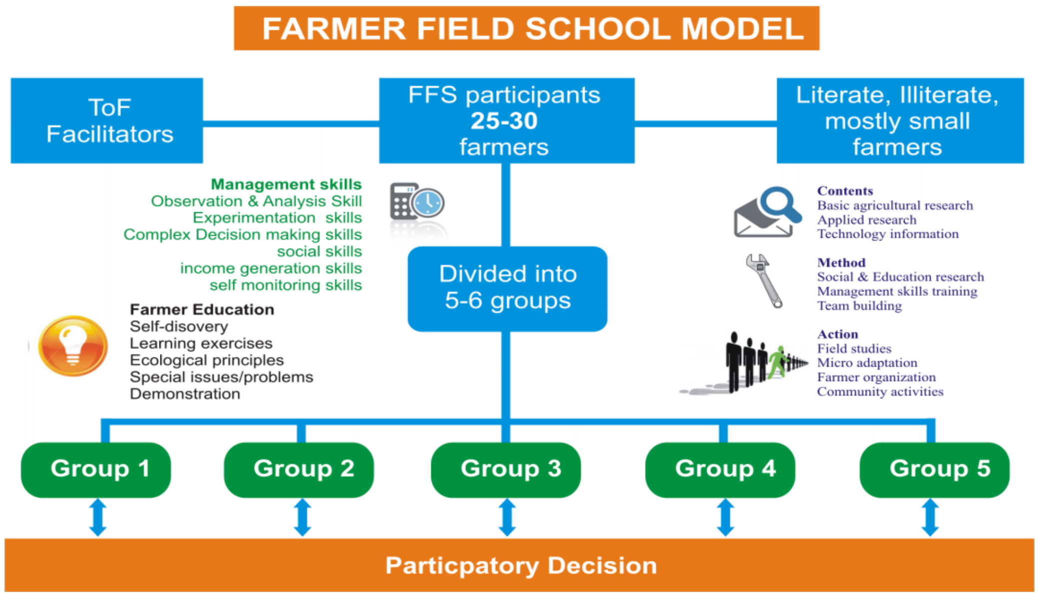
## Training of Facilitators

The purpose of TOF is to develop a team of IPM Trainers/Facilitators from existing extension departments, research institutions/ organizations, NGO's and FFS trained farmers to train / facilitate farmers in IPM under FFSs. In a TOF, 25 participants are trained over a cropping season. For first two days of each week, the ToF participants observe a selected field and do the Agro Eco System Analysis (AESA), a tool of field observation. Afterward they discuss their observations in the field including the soil and crop health, agronomic requirements, insect pests and their natural enemies etc. This is done throughout the season of the crop. For next two days the ToF participants divided into groups of 5 each to run 10 FFSs and interact with two groups of 25 farmers each in 10 FFSs (with 250 farmers). In this way a team of facilitators develops, which is professionally well good, motivated and fit for proper facilitation of the farmers regarding integrated pest management.

## Farmer Field School

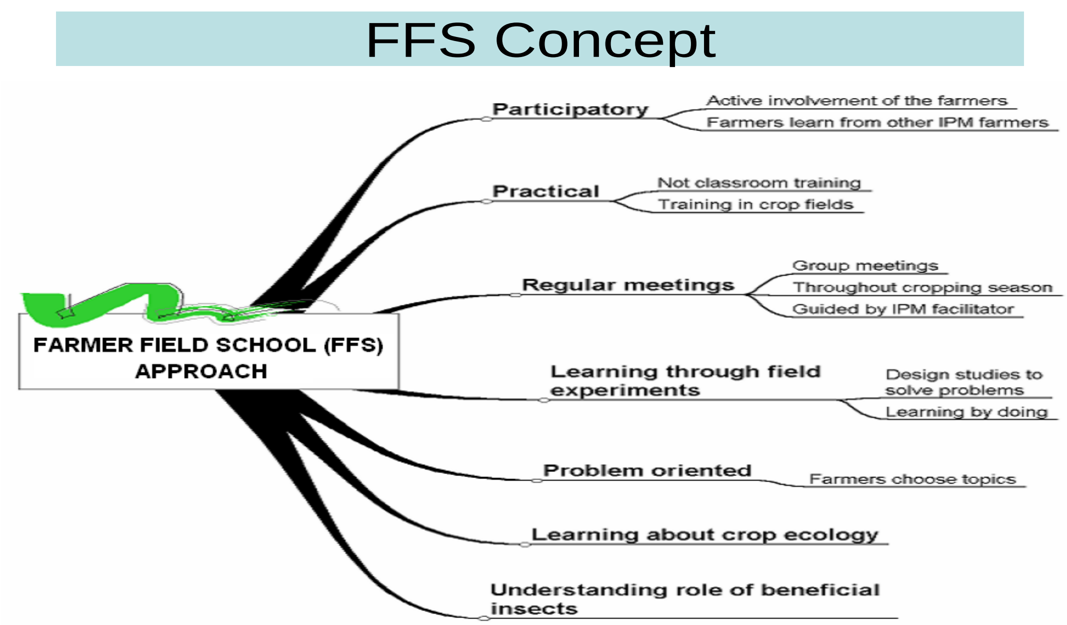
Each FFS contains 25 farmers where participants do the Agro-Eco-System Analysis AESA under direct supervision of trained facilitator. They observe the field, crop growth, pest problems etc. draw their figures and present results on the basis of which further cultural practice and action is decided collectively. If something is not clear, some short & very simple experiments (not too scientific) are set up to resolve the problem. Thus, the farmers become well organized, learn to work in community, become able to make their own day-to-day decisions and develop expertise to the extent that they can manage crop production issues without external support of chemical companies or extension staff. In this way farmers are introduced with discovery based learning process, which empower the farmers for better utilization of available farm resources. Farmers Field School model and Farmers Field School concept adopted by IPM program Pakistan is given below in diagrammatic format.

**FIGURE 10: FARMER FIELD SCHOOL MODEL**




*Source: National IPM Programme*

**FIGURE 11: FFS CONCEPT**




*Source: National IPM Programme.*

## FAO-EU IPM Programme For Cotton In Asia (2001-2004)

The FAO-EU IPM Project (2001-2004) was executed in six countries (Pakistan, China, Bangladesh, India, Philippines and Vietnam) for rural poverty alleviation and agro-biodiversity protection by following ecosystem-based production and pest management approaches. The focus of the program was to develop training capacity and to educate cotton farmers about the agro-ecosystem and to verify and further develop environment friendly pest control strategies. The skills training took place in weekly, season-long practical sessions called FFS. Under this project a total of 425 IPM facilitators from existing extension departments, research institutions/ organizations, NGO's and Farmer Organizations were trained in 12 ToF courses. A total of 525 crop season long FFS were organized in provinces of Punjab, Sindh and Balochistan. The total number of beneficiaries was 12,999 farmers.

To encourage women's participation, AGFUND initiated a project on "Pesticide Risk Reduction for Women in Pakistan". It focused on training of female facilitators to reach rural women in the traditional, gender-segregated society through Women Open Schools. The emphasis was given on the toxicity and health risks of pesticides among others. Under this project, 1,000 women farm workers were trained through 19 Women Open Schools (WOS) in Sindh and Punjab province.

## Government Funded National IPM Project (2004-10)

As a Follow-up of FAO-EU IPM Programme for Cotton in Asia, the Government of Pakistan launched a PSDP-funded Project: "National Integrated Pest management" (2004-10). National IPM Programme PARC executed this project with the collaboration of Provincial Agricultural Departments and IPM Farmer Organizations. Project activities were implemented in all four provinces. The primary objective of was the capacity building of farmers through establishment of IPM based ToF and FFSs education approach to manage fruit, vegetables, rice and cotton crops. FFS approaches promoted IPM through enhancing farmer's understanding of the ecological principles behind the safe and effective management of harmful insect pests and disease causing pathogens. During project life span a total of 532 IPM facilitators were trained in 19 IPM crop season long ToF courses held in 19 districts. It also conducted 1872 crop season long FFS in Punjab, Sindh, Khyber Pakhtunkhawah, Balochistan and Gilgit. The total number of beneficiaries was 45557 farmers.

## Status Of Capacity Built In IPM-FFS Approach

The National IPM Programme of NARC Islamabad is mandated to provide technical backstopping and support to all federal, provincial institutions, NGO's and farmer organizations involved in the implementation of IPM through FFS education approach throughout the country. As a result of several activities undertaken during past several years a team of 2,770 trained facilitators has been developed through 107 ToF and 6,664 FFS, WOS and Children's Ecological Clubs (CEC). Hence a total of 141,700 Farmers including women & Children imparted crop season long FFS training on different crops throughout Pakistan. The program with the support of Government of Pakistan, FAO of United Nations, ICARDA and other National and International donors has also initiated FFS and conducted enormous experiments on Kitchen Gardening, Integrated Livestock Management, Wheat management with respect to Rust diseases, Food preservation and integrated Management for Bee keeping. At Present to educate the farmers in any field of agriculture and livestock the inclusion of FFS education approach is a routine practice by the private and public sector at national level. Specific dates are given below. The work done by some FFS implementing organizations is not updated. Hence it is anticipated that the number of FFS trained Farmers would be more than 0.2 million.

## TABLE 23: STATUS OF CAPACITY BUILDING

| Gender | ToF/ToF | Facilitators Trained | FFS/WOS/CEC | Farmers Trained |
|---|---|---|---|---|
| Female | 10 | 302 | 954 | 24330 |
| Male | 97 | 2,468 | 5,710 | 117370 |
| **Total*** | **107** | **2,770** | **6,664** | **141,700** |

*Source: National IPM Programme*

## TABLE 24: CROP/COMMODITY WISE TRAINING OF FARMERS UNDER IPM BASED FFS APPROACH

| Crop | FFS | Farmers Trained |
|---|---|---|
| Cotton | 3903 | 74056 |
| Wheat | 58 | 1357 |
| Vegetables | 1328 | 32602 |
| Date Palm | 196 | 4534 |
| Mango | 564 | 13724 |
| Citrus | 238 | 5950 |
| Apple | 73 | 1615 |
| Sugarcane | 11 | 220 |
| Rice | 182 | 5487 |
| Live-Stock | 39 | 135 |
| Maize | 50 | 1,250 |
| Bee Keeping | 9 | 315 |
| Food Preservation | 13 | 455 |
| **Total** | **6,664** | **141,700** |

*Source: National IPM Programme*

## TABLE 25: PUBLIC AND PRIVATE SECTOR INVOLVED IN CAPACITY BUILDING OF FARMERS & FACILITATORS IN IPM-FFS APPROACH

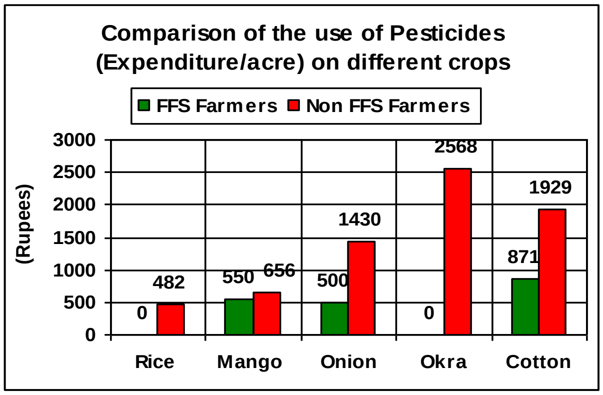
| Institute/Organization | ToF/WToF/ FToF | Facilitators Trained | FFS/WOS/ CEC | Farmers Trained |
|---|---|---|---|---|
| Nat-IPM-FAO-EU | 17 | 479 | 525 | 12999 |
| Nat -IPM-AG, Fund | 3 | 78 | 61 | 977 |
| Nat-IPM Project | 19 | 532 | 1872 | 45557 |
| Plan-Pak, Vehari | 3 | 74 | 96 | 2087 |
| KWA-WWF-Pak | | | 99 | 2114 |

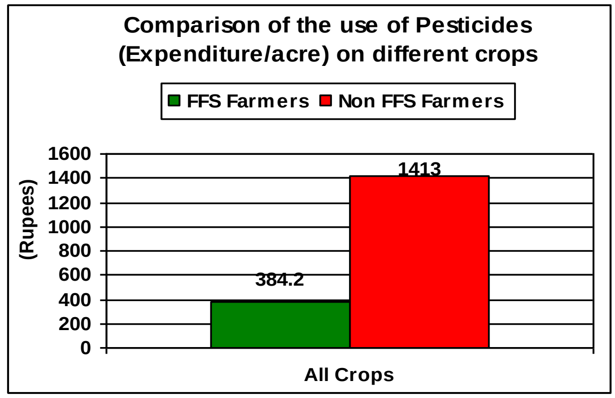
| Institute/Organization | ToF/WToF/ FToF | Facilitators Trained | FFS/WOS/ CEC | Farmers Trained |
|---|---|---|---|---|
| WWF-Pakistan | 6 | 150 | 201 | 4509 |
| KWA-FAO-Kashmir & Bwp. | 1 | 32 | 86 | 2330 |
| KWA-UNICEF | | | 20 | 1400 |
| Lead-Pakistan, Sindh | | | 14 | 260 |
| CCRI-Sindh (MINFAL) | | | 12 | 300 |
| CARITAS-Sindh | | | 12 | 300 |
| Dev-Con-UNDP | | | 8 | 200 |
| PRSP-Khanewal | 5 | 141 | 475 | 10498 |
| Agri. Extension, Punjab | 32 | 800 | 2074 | 28818 |
| Agri. Extension, Sindh | 1 | 25 | 25 | 625 |
| Agri. Extension, Balochistan | 2 | 44 | 80 | 2000 |
| Agri. Extension, Khyber Pakhtoonkhawah | | | 128 | 3200 |
| Agri. Extension, Gilgit, Baltistan | | | 40 | 1000 |
| OFWM, Sindh | 6 | 158 | 335 | 9881 |
| Agri. Extension-Punjab-Fruit & Veg | 2 | 50 | 200 | 5000 |
| Society of Facilitators and Trainers | 10 | 207 | 291 | 7495 |
| WADO-Sindh | | | 10 | 150 |
| **Grand Total** | **107** | **2770** | **6664** | **141700** |

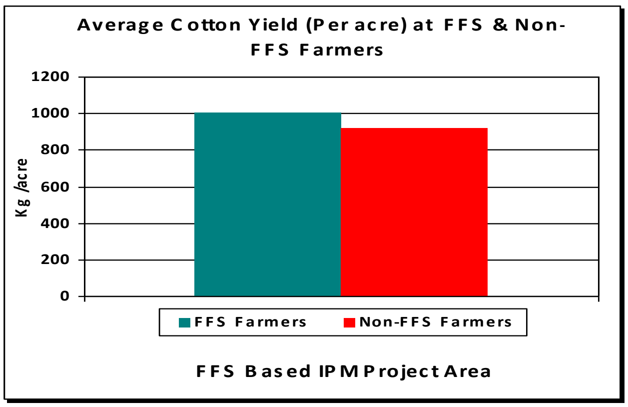
Source: National IPM Programme

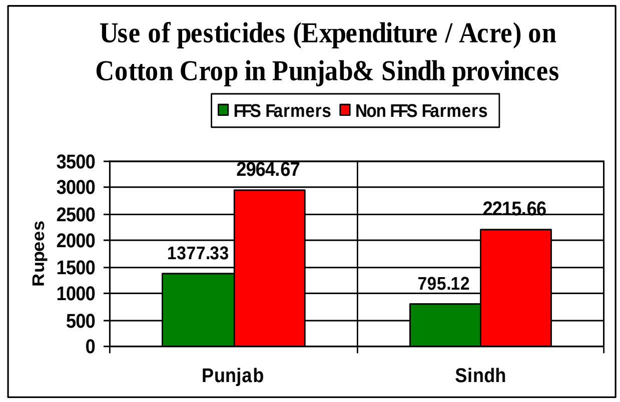
With regard to quantitative outcomes, the IPM programs in Pakistan have been able to: develop a trained cadre for agriculture information dissemination, sensitize community regarding pesticides and its impact on ecosystem and involve women in activities. The impact of the IPM program is not conclusive as no impact assessment evaluation has been carried out by any independent third party. However an IPM impact assessment study carried out itself by National IPM Programme showed that FFS Farmers have reduced average pesticide use in all crops (under study) by 72.81% as compared to the non FFS farmers while in Cotton crop, FFS Farmers have reduced pesticide use by 58.06%. They have achieved 10.5% more cotton yield / acre and achieved more Net profit by 25.54%.  FFS Farmers have reduced input cost by 73% expenditure on Pesticides, 11% on Fertilizers, 39% saving on Irrigation expenses. Some of the data generated by this study is expressed graphically are given below.

**FIGURE 12: SELECT IMPACT ASSESSMENT STUDY DATA**




## Establishment Of Facilitator's & Farmer's Community Organizations

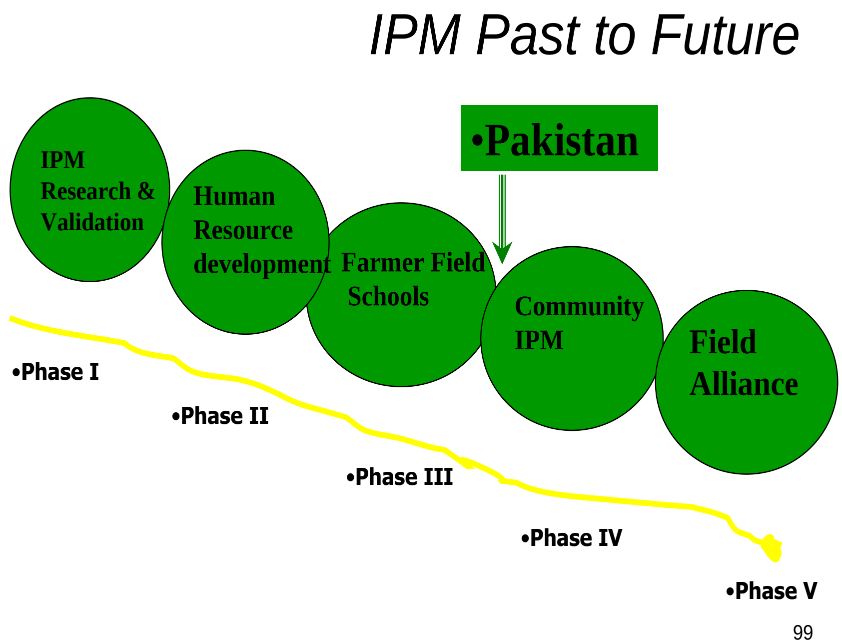
For continuity and refreshment of knowledge and skills of the facilitators/farmers, annual facilitation skills enhancement workshops, farmers' congresses, workshops on community and leadership management were organized. As a result of this process various associations/organizations of IPM farmer facilitators and women facilitators have emerged and working sustainably by generating their own resources/with support of public & private sector and NGO's. The women trained through, Women Facilitators Training (WFT) approach has established their organizations independently or under the joint venture with male farmer facilitators in their respective areas. They have up-scaled themselves by making several innovations. Women organizations are working with NGOs, public and private, national and international organizations. They have completed various development projects where they have worked for the capacity building of rural women in different fields of livelihood such as poultry & livestock management, literacy, stitching, embroidery, kitchen gardening, health measures and micro credit schemes. A total of 28 organizations have been developed or registered under this program. The detail is given below.

## TABLE 26: LIST OF IPM FACILITATOR'S & FARMER'S COMMUNITY ORGANIZATIONS (REGISTERED) DEVELOPED UNDER IPM BASED FFS PROCESS

| Community Organization | |
|---|---|
| KWA | Kissan Welfare Association, Bahawalpur |
| KWA | Kissan Welfare Association, Muzafar Abad, AJK |
| KF | Kissan Foundation, Rahim Yar Khan |
| KF | Kissan Foundation, Multan |
| KF | Kissan Foundation, Muzafargarh |
| KF | Kissan Foundation, Gujranwala |
| KF | Kissan Foundation, Sargodha |
| FIDA | Farmer Integrated Development Association, Vehari |
| KDA | Kissan Dost Association, Khanewal |
| KDO | Kissan Dost Organization, Bahawalpur |
| SAO | Sustainable Agriculture Organization, Khairpur |
| WADO | Women Agriculture Development Organization, Khairpur |
| WADO | Women Agriculture development Organization, Balakot, |
| FFO | Farmer Facilitator Organizations, Khairpur |
| IDF | Indus Development Foundation, Khairpur |
| SAFE | Sustainable Agriculture & Friendly Environment, Shaheed Benaziarabad |
| RADO | Regional Agriculture Development Organization, Noshero Feroze |
| NAFO | Natural Agriculture Farming Organization, Sanghar |
| FAIDO | Farmer Agriculture Innovative Development Organization, Mirpurkhas |
| SADA | Sindh Agriculture Development Association, Mithi |
| IFWA | Indus Farmer Welfare Association, Ghotki |
| GALA | Ghotki Agricultural & Loyal Association, Ghotki |
| MAWA | Moan Jo Daro Agriculture Welfare Association, Larkana, |
| SAFWO | Sustainable Agriculture Farmer Welfare Organization, Sukkur |
| RDSA | Rural Development Support Association, Bala Kot |
| SOFT | Pakistan- Society of Facilitators and Trainers, Islamabad |
| LIFE | Linkages Initiatives for Farmers Educations, Gilgit |
| WAFA | Women Agriculture and welfare Association, Bahawalpur |

*Source: National IPM Programme*

**FIGURE 13: IPM PAST TO FUTURE**




Source: National IPM Programme.

## Biological Plant Protection Measures In Pakistan

There has been a severe competition for food between human societies and pest populations. Cumulative loss due to insect pests has been enormous running in to trillion of rupees. With the advent of synthetic pesticides the pest control has mostly been achieved through these chemicals. The greater reliance on chemical control was placed due to its mass appeal. To reduce reliance on chemical control, concept of IPM emerged. At national level unfortunately Pakistan has pesticides based IPM so biological plant protection measures are very weak.

Biological control has an important role to play in modern IPM but can never provide a complete solution to pest problems. Among the benefits of biological control, one important is that there is no harmful effect on other beneficial organisms or hazards to humans or wildlife. Also, pests do not become resistant to natural enemies in the way that they do to insecticides. Biological control once established is largely self-sustaining, as natural enemies tend to respond to increases in the populations of their hosts. For these reasons renewed impetus has been given to biological control in recent years, particularly as a component of management systems.

Work on biological control of insect pests has been started since inception of Pakistan. Scattered investigations were going on in different research and teaching institutions of the country. However detail research was started with the establishment of Commonwealth Institute of Biological Control (CIBC) at Rawalpindi in 1956. Since then, comprehensive basic work has been done. So far the knowledge mass on biological control consists of 750 numbers of insects whose natural enemies have been made known while 700 natural enemies were recorded by PARC.

In Pakistan practical biological control has been exploited mainly on sugarcane insect pests with tremendous success. Several sugar mills now independently run their own program in Pakistan. Millions of rupees have been saved through augmentation and conservation on natural enemies of sugarcane insect pests. Additionally benefits have been achieved in the shape of lesser pollution in the environment. Horticultural crops are another area where biological control measures can be exploited. Some of successful efforts have been made to tackle scales and mealy bugs by natural enemies which cause enormous damage. Recent example to quote is success in biological control of mealy bug in cotton in Pakistan achieved under the federal government sponsored project "biological control of major cotton pests including mealy bug". Having major breakthrough in biological control of mealy bug the programs on biological control of other pests including whitefly, jassids, and armyworm bollworms have been initiated on pilot area of 500 acres area each at Bahawalpur and Mir Pur Khas.

Other classical examples are biological control of woolly aphid on apple, through successful introduction of a parasitoid *Aphelinus mali* from Switzerland in 1984, *Cotesia flavipes* against borers in sugarcane and maize in 1961, *Telenomus remus* and *Euplectrus platyhypanae* from Bardbados in 1980, 1981 against armyworm; *Bracon kirkpatricki* and *Chelonus blackburni* against cotton bollworm in 1981; *Prospaltella perniciosi* in 1959 against San Jose scale on apple, *Leptmastix dactylopi* from Texas against grape mealy bug in Quetta valley in 1982. Besides these about 25 beneficial species were imported from different countries at different times and released in Pakistan. However, their status if they are established in Pakistan is not clear. Biological control programs for fruit flies have also been initiated by CABI Pakistan.

Although large number of farmers have been sensitized in biological control approaches but the whole approach has not attained high momentum. One of the reasons has been non-availability of modern system of mass rearing of natural enemies. No private company is involved in biological control measures business. Availability of trained human resource is another problematic area, which is not presently available. There is no specialized institute in Pakistan on this topic. The work is mostly scattered that need to be coordinated to expand this activity both for knowledge enrichment and applied purpose.

## Biopesticides Status In Pakistan

Exploitation of plant based and microbe based bio pesticide is under consideration in Pakistan since long. PARC had undertaken study on various plant materials to find effectiveness but only able to develop Neem (Azodirachta indica) based bio control agent as commercial products i.e. *Nimbokill* and *Nimboli*. The *Nimbolill* was prepared for use against crop insect pests while *Nimboli* was against house insects such as mosquito. These products were marketed but could not get popularity. For weed management, University of Agriculture, Faisalabad has been involved for the last twenty years to develop plant water extract based herbicide and has found some success in managing weeds. But however no product was commercialized up till now. With regard to microbial-based bio pesticides, several products are registered and have good market potential in Pakistan. Products as biopesticides or biological like abamectin, *Bacillus thuringiensis*, azadirachtrin, Gossyplure, *Heliothis armigera* NPV, oxymatrine+prosuler, *Pectinophora gossypiella*, spinetoram, spinosad, and trialkoxydim are in use as commercial products in Pakistan. Another biopesticide registered for agricultural use in Pakistan, but RUP for agricultural uses in USA is emamectin benzoate.

## Impact Of Pesticides On Agro-Biodiversity In Pakistan

Because of extensive use of pesticides in the country the natural control of pests has severely suffered and crop production system has reached a stage where no crop is possible without pesticides. Pests resurgences have become a common phenomenon resultantly pesticides sprays have to be made repeatedly. In 1960s, three bollworms species and a bug were the major pests of cotton. Contrarily Pakistan now has extended list of pests in cotton that include 11 major pests. Secondary pests have now become the major pests in crops. Some of the pests such as fruit flies, army worms, thrips, jassids, whiteflies and mealy bugs have become difficult to control by routine pesticides spraying so alternate measures are needed that strengthen the natural control of pests.

As such there is not much documented evidence of decline in biodiversity at national level; however, decline in natural control of pests in some cases reported by CABI Central and West Asia (CWA) gives reflection of the existing situation of impact of pesticides on agro-biodiversity. Above 50% parasitism was reported in fruit flies in 1970s that went even below 3% in 2003-05 (CABI Final Report 1968-72 and CABI Final report 2002-2006).

The scarcity of the natural enemy fauna in Pakistan agro-ecosystem was experienced severely in 2005-06 when mealy bug accidently entered Pakistan and because of weak endemic natural enemy fauna it increased to high proportions. Two predators namely *Chrysopa* species and *Coccinella septempunctata* were found attacking the mealy bug in small numbers in 2005-06. With conservation practices started in 2007-08 in Punjab, Sindh and Balochistan under MINFA sponsored project 13 species of predators and a parasitoid had the chance to shift to this alien species and largely contributed in bringing down mealy bug populations. (CABI Annual Reports 2007-08 and 2008-09). Because of slowing down of conservation practices from 2010 and increased pace of pesticides use the mealy bug has once again started increasing in 2011 (2010-2011 reports of the Department of Pest Warning and Pesticides Quality control Government of Punjab). Other important negative effects of pesticides overuse are the loss of honeybees, crop pollinators, soil dwelling insect predators and other useful fauna.

## IPM in 2014

Since 2013, several factors, including information and ideas in the 2011-2013 Programmatic PERSUAPs, have led Pakistan to consider additional changes to its agriculture and IPM systems.

As of 2014, Pakistan has developed a Future Action Plan for IPM strengthening. The National IPM Programme with the support of Government of Pakistan, FAO, ICARDA and other National and International donors has provided technical backstopping and support to all Federal, Provincial Institutions, NGO's and Farmer Organizations in the implementation of IPM practices. The Programme has built the capacity of the Farmers, community activists and the Extension officials (Agriculture Officers and Field Assistants) of the Departments of the Provincial Agriculture Extension through the crop season-long trainings on IPM of Cotton, Wheat, Rice, Fruit and Vegetable crops under the process of FFS approach in all over the country. In this way only 1, 41,700 Farmers have been trained in IPM practices and technologies. These are just less than 3% of the total 5 million farming families in Pakistan and rest of the 97% growers is still need to be educated. Hence at this stage, where the IPM- FFS trained farming communities are moving towards their sustainability and livelihood improvement, it is strongly suggested that the existing National IPM Programme, NARC may be strengthened by providing a sufficient fundings and well educated human resources for achieving the following planned objectives:

- Development of National IPM Coordination Hub of Federal/ Provincial Agriculture Departments, Farmer Organizations and NGOs
- Enhance communication, coordination and strengthen collaboration among IPM stakeholders.
- Introduce/promote IPM philosophy in educational institutions by pursuing respective departments for inclusion of IPM policies and syllabi in schools, colleges and universities.
- Promote and coordinate research & development in IPM including study of various agro ecosystems and indigenous knowledge.
- Facilitate review of plant protection and IPM policies
- Make efforts to promote ecologically sound and issue oriented IPM approaches for the benefit of the

society.

- Introduce/promote IPM philosophy in educational institutions by pursuing respective departments for inclusion of IPM policies and syllabi in schools, colleges and universities.
- Enhance public awareness and establish IPM information network (NIPMIN) to provide updated science based information to the stakeholders.
- Facilitate and coordinate IPM implementation by provincial extension departments and promote cooperation & collaboration between institutions and provinces.
- Nat-IPM includes policy analysis, education, information dissemination & public awareness, research & development and field implementation, which are individually described as under;
- Scale up of IPM-FFS based evolved technologies and products
- Promotion of Farmer Participatory Research activities country wide.
- To provide the technical backstopping to on-going IPM-FFS activities
- Skill/education-based technology transfer.
- IPM Education and awareness to comply with WTO obligations.
- Commercialization of IPM-FFS based evolved technologies and products.

During 2013, Pakistan also listed the following foresights for future interventions in agriculture.

Pakistan lies in the fastest population growing country of the world and its population is expected to reach 33.3 million by 2025. In future there will be increasing drive to move away from intensive farming practices towards a more sustainable and environmentally sensitive approach for food production. In the field of disease management, this trend will be supported by objectives aimed at minimizing chemicals usage, and encouraging the research and deployment of more target specific, less environmentally harmful chemicals.

Research will be required to concentrate in the following areas to boost in the agriculture production to cater the food demand of the country along with healthy environment.

### 1. Biological Control

Bio-control agents will be introduced to:

- Replace Chemical fungicides
- Reduce atmospheric pollution
- Disturb population dynamics of pathogens and pests
- Reduce the development of resistance in pathogens

### 2. Biotechnology and Genetic Engineering in Plant Diseases

Biotechnology will be used as follows:

- Marking of resistant genes of the major diseases of crops and their incorporation in the commercially grown acceptable crop varieties.
- Screening of vegetables, field crops and fruit plant varieties against mycoplasma, viruses and viroides and multiplication of this resistant material through tissue culture.
- Efficiency in use of biotechnology can also be enhanced through:
- Molecular diagnostics
- Biomarkers of disease
- Identification of new diseases

- Remote sensing
- Information networks
- Plant defense, signaling pathways and plant immunity through induced plant resistance and plant defense activators
- Accessing and exploiting genetic diversity through
- Genetic diversification
- GM approaches to crop resistance
- Understanding susceptibility
- Costs and benefits of durable resistance
- Conservation of genetic resources

### 3. Integrated Diseases Management (IDM)

Integrated diseases management strategies will be developed to minimize use of chemicals and to create epidemiological modeling under changing scenario.

Evaluation/development of integrated plant protection/disease free techniques for various crops under changing climatic conditions

### 4. Bio- Informatics

Development of techniques for disease diagnosis and control on the basis of information technology, scientific data base and computer models and diseases models for the prediction/forecast to prevent from epidemics.

### 5. Establishment of Virus Free Fruit Plant Nursery for:

- Large-scale production of virus free seedlings and plants of different horticultural crops.
- Studying resistant transgenic germplasm against virus and viroids.
- Transferring of tissue culture technology in the private sector as well as progressive farmer's field.
- High light tunnel technology to the farmers with advantages and disadvantages.
- Projection of advance technology through multimedia etc.
- Usage of bio-agent as fertilizer etc.
- Studying alternate host for viruses i.e. weeds, herb etc.

### 6. Use of Petroleum Based Pesticides

The use of petroleum based pesticides is increasing being the safer than the currently available synthetic pesticides, which could have minimum residual effect.

### 7. Revision of Pesticides List

The list of pesticides used in Pakistan must be revised each year and the pesticides being used more than 5 years must be restricted by law, as in advanced countries.

### 8. Organic Farming

The government must support the culture of organic farming by providing certain incentives to the farmers and growers, in order to avoid the issue of MRL and also the availability of safe food.

## Fruit Plant Nurseries

Pakistan is blessed with diversified agro-ecological conditions suitable to grow almost all kinds of fruits and vegetables; however, some of them are grown on larger areas. There is great potential of increasing the production of these crops as well as introducing new crops on commercial scale. There has been a significant increase in area and production of major fruits in the country during past four decades. The data show that area of fruits increased from 325 thousand hectares in 1975 to 818 thousand hectares in 2011-12 showing an increase of 152%. Similarly the production of fruits for this period increased from 2112 thousand tons to 6996 thousand tons showing an increase of 231%. It is further to add that the cropped area under vegetables, condiments and fruits for the above period has increased from 0.7, 0.3 & 1.2 percent to 2.0, 1.0 & 4.0 percent respectively. This reflects that horticulture crops were more profitable to growers who shifted to these commodities in due course of time.

The situation reflects that per hectare yield of different fruits have not shown significant change during past and the increase in production resulted mainly from increase in area. This is a matter of concern as most of the countries of world have improved the productivity of many horticulture crops significantly and they were getting much higher yields. It is observed that there was a yield gap of about 60-80% for different crops as compared to different countries of world. Further, the progressive growers who adopted improved technologies / management practices were also getting 2-3 times higher yields than the average yield which show that there was enough room for improvements.

There are many reasons for static or low yields of horticulture crops but the most important factor is the adoption / introduction of improved varieties and use of certified nursery plants.

### Use of Certified Planting Material

The planting material i.e. the nursery fruit plants is the base for future production. If the base is not set on sound footings, it shall affect the whole production period of any commodity. This is even more important for fruit crops where the plant has to stay in the field for many years to come and any defect at initial planting shall continue to affect production for whole life. It is estimated that the use of certified plants may improve future yields by 10-15%. Most of the fruit plants are vegetatively propagated and thus the bud wood or graft wood must be healthy when used for propagation. There are many diseases and viruses that are mainly transmitted through vegetative crop parts used for propagation or the tools used for this purpose. Further, to control the soil borne diseases, it is important to use pathogen free soil media.

The whole system to control and restrict the spread of diseases and viruses and maintaining the purity of original variety, is only possible through establishment of "Certified Fruit Plant Nurseries". Currently, there is no system for certification of nursery plants hence the growers are obliged to use the planting material from available source with several deficiencies. If the horticulture sector is planned for progress on sound basis, the nursery certification system for major fruits like Citrus, Mango, Apple, Pear, Peach, Plum and Apricot has to be established on scientific lines for supply of quality planting material. In this regard establishment of certified nurseries are required for real progress in the sector.

The concept of the nursery certification is based on the principle of producing the planting material which is free from any viral or fungal diseases so that it could remain healthy for a longer period with appropriate management. It is mainly based on preventive measures rather than control. For a strong Nursery Certification System, most important step is to establish a Germ Plasm Unit (GPU) of Mother Plants of improved Rootstock and Scion Varieties. The purity of original varieties is maintained through Shoot Tip Grafting/ Tissue Culture or proper indexing. The seed and bud wood for raising nursery must come from the GPU. The tools used along with soil and containers must be sterilized before start of any operation. For a successful nursery production, one must have well trained technicians to undertake all the operations as prescribed in the system. The GPU's and the certified nurseries must also have the analytical support for detection of diseases and viruses at appropriate periods. The Federal Seed Certification & Registration Department (FSC&RD) of the Government of Pakistan is providing such service currently but other Public Sector institutions must also come forward for the purpose.

### Current Status

Currently there is a mushrooming growth of fruit plant nurseries in the country particularly in specific fruit production areas. There is no check or restriction on any individual to stop him from establishing the nursery. The certification system for fruit plant nurseries is still in its infancy stage although the importance have been felt and recognized since long but with little progress. The pioneering work was done by the Swiss assisted Fruit Development project in Khyber Pukhtoonkhwa where about twenty certified fruit plant nurseries of Pome and Stone fruits were established in Swat Valley and registered with FSC&RD. They are reported to produce about 50-60 thousand plants per year duly certified by FSC&RD, however, some professionals have reservations about the system and claim that such plants may fall under the category of “Truth-In-Labeling”. Recently, the Australian assisted program Agriculture Sector Linkages Program has also initiated the nursery certification program for Citrus and Mango but still there is a long way to go to claim for producing certified plants. The FSC&RD is the controlling authority for the purpose and is in the process of formulating the procedures and Rules & Regulations. The Rules and Regulations for Pome and Stone Fruits were notified in 2003 while the same for Citrus, Mango and Guava are in the process of approval.

Since the whole system is prevention rather than control based so there is no specific pest control measures are suggested against which the certification is being carried out. However with regard to other insects, pathogens and weeds, the pests and control measures are similar to the main plants.

## Food Safety, Trade Standards and HACCP in Pakistan

Presently Pakistan is in a position to export food grains including rice and wheat. It has traditionally been also an exporter of fruits and vegetables, which are known the world over for their inherent characteristics of quality, taste and flavor. International trade has become more competitive due to setting in of the WTO regime. It on one hand asks for a level playing field to all member states and on the other, encourages member countries to introduce standards in order to protect human, animal and plant health.

Two significant agreements concerning food safety, animal and plant health under WTO are: (i) Application of Sanitary and Phytosanitary (SPS) measures, and (ii) Technical Barriers to Trade (TBT). SPS agreement encourages members to apply international standards to ensure that the food entering the supply chain is safe for the consumers and is free from injurious diseases including animal and plant. While, the WTO itself is not a standard setting body, it encourages adoption of standards set by the international standard setting bodies like; Codex Alimentarius Commission (for food laws), International Plant Protection Convention (IPPC) (for plant and plant health), and World Animal Health Organization (OIE) (for animal and animals products).

Safety issue is a major cause of concern of all the international and domestic consumers. The international trade has, therefore, become more competitive both in terms of competitive advantage as well as safety issues. Recently food scandals and outbreak of food borne diseases have added pressure on the exporting countries to tighten rules and their enforcement, Pakistan being no exemption. However, the country is facing stiff challenges in international markets, due to non-compliance of SPS measures, resulting in frequent bans, rejections and confiscation of its export consignments of agro-based commodities at destinations. Various studies have highlighted the need to have a strategy for quality and SPS management in relations to its trade. Such reports have also identified the need to enhance capacities for quality and SPS management to overcome the systematic supply chain weaknesses, including traceability, to overcome potential hazards in food safety. In order to increase Pakistan’s share in the export trade market, it is imperative that Pakistani exporters use quality and SPS standards to their competitive advantage.

In Pakistan, the Acts and Laws relating to quality standards and animal and plant health standards have been framed even before the enforcement of WTO regime e.g.;

(i) Pakistan Plant Quarantine Act, 1976 being administered by Department of Plant Protection (DPP) but does not include plant and plant health issues relating to export. The Act however defines measures to protect imports of plant material only;

(ii). The Pakistan Fish Inspection and Quality Control Act, 1997 focuses to regulate quality and promote export of fish and fishery products and there is no mention of import of fisheries items;

(iii). The Agricultural Produce (Grading & Marking) Act, 1937 provides for grades and marking of agricultural produce. The quality standards framed under this Act do not include current quality issues concerning international trade like; pesticides residues in food and agricultural commodities, veterinary drugs in milk, poultry, fish and food additives, contaminants including those not intentionally added to food; and;

(iv). The Animal Quarantine (Import and Export of Animals and Animal Products) Act, 1979 also needs to be revisited in light of the agreement on application of SPS measures.

### Establishment of an Integrated SPS Management and Official Control System

Recognizing the need to facilitate Pakistan's trade of agro-based commodities, a development project titled "Specialist Programme for Strengthening SPS Facilities and Quality Inspection Services in Compliance with WTO – Establishment of an Integrated National Animal and Plant Health Inspection Services (NAPHIS)" is under execution by Ministry of National Food Security and Research. The objective of this project is to strengthen the existing regulatory mechanism for compliance of agricultural produce in line with the international standards of food safety. The NAPHIS is coordinating with line departments engaged in standards setting and SPS management. For the purpose, the DPP, Animal Quarantine Department (AQD), Federal Seed Certification and Registration Department (FSC&RD), National Veterinary Laboratories (NVL), Marine Fisheries Department (MFD) and Grain Quality Testing Laboratories (Islamabad & Karachi) of NARC have been facilitated to enhance their capabilities in inspection and certification process.

The NAPHIS project is now in the process of reviewing the existing Acts and Laws and the standards of quality of agricultural products to harmonize them with international standards. Further, two new lab buildings of Grain Quality Testing Laboratories (GQTL), one each at Islamabad and Karachi have been constructed with the support of NAPHIS Programme. State-of-the-Art laboratory equipment has also been provided by NAPHIS to Grain Quality Testing Lab, NVL, FSC&RD and MFD. The quality control laboratories of GQTL (Karachi & Islamabad) are internationally accredited, whereas, the quality control laboratories (chemical and microbiological) of MFD have also acquired international accreditation status. The Labs of FSC&RD and NVL have applied for accreditation status with the national accreditation bodies. The modern SPS management control system is based upon science-based controls with separation of regulatory control from voluntary standards to avoid conflict of interests with Government law enforcement bodies. The Supply Chain Management is managed through integrated controls applied at farms, processing levels and distribution but requires significant improvement. The integrated SPS official control includes surveillance, inspection and enforcement through a unitary central coordination of food safety, animal and plant health to avoid gaps and overlapping in coverage.

In order to have an effective and integrated SPS management and control system, the NAPHIS has finalized a draft Bill for establishment of National Food Safety, Animal and Plant Health Regulatory

Authority which has been submitted to M/o NFS&R for approval by the Cabinet and enactment by the Parliament. The Bill covers all aspects of SPS controls through consultative process, which includes Scientific Committee and Consultative Committee to assist the authority in ensuring official controls. Coordination with the Provincial Government has been ensured through participation with Provincial Government officials. The Bill also includes support of laboratory analysis of samples to evaluate the quality of export and import consignments, and also for training and SPS awareness programmes.

The four key functions proposed to be performed by the National Food Safety, Animal and Plant Health Regulatory Authority includes: (i) setting technical regulations to govern import and export, (ii) operation of border inspection posts, (iii) international cooperation SPS measures. Liaison with international bodies (WTO) in terms of SPS queries and notifications; and UN mandated bodies (Codex Alimentarius Commission) for food safety; OIE for animal health and IPPC for plant health; and (iv.) coordination with Provincial Governments on SPS functions. Once the authority is in place, it will put in place an integrated SPS management and control system, capable of addressing issues like hazardous products, animal, plant throughout the agro food, supply chain.

### Linkages of GAP, HACCP & Environment with Trade

The growers and processors are encouraged to adopt Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP). Due to improved SPS management and Global GAP Certification by exporters of citrus fruits and mangoes, the country has been able to gain market access for citrus and mangoes in USA, Japan, Jordan, Russia and Australia.

The environmental and safety standards can be tackled by application of GAP and HACCP. The GAP approach helps to acquire environmental, social and economic benefits. It contributes to environmental, economic and social sustainability of on-farm production, resulting into safe and healthy food to the consumers. The three pillars of GAP are: (i) economic viability, (ii) environmentally sustainability, and (iii) socially acceptability. The GAP includes management of soil, water, crop and fodder production, crop protection, animal production harvest and on-farm storage, human welfare, health and safety and Eco system. International trading partners encourage import of goods from GAP certified farms and enterprises. A good number of Pakistani exporters of citrus fruits and mangoes have now acquired Global GAP certification.

HACCP system is a process, which is science, based and identifies specific hazards and measures to ensure the safety of food. HACCP is a set of established control system that focuses on prevention rather than relying on end product testing. HACCP involves multidisciplinary approach to include agronomy, veterinary health, production, microbiological, public health, food technology, and environmental health. It is currently a system of choice in the management of food safety.

The food processing units include: fish processing, and fruit juice/jams. Enterprises are encouraged to adopt HACCP system of control to enhance confidence of foreign buyers in product safety. The SPS management supported by trade inspection services and internationally accredited laboratories will minimize the fears of exporters in form of rejection, detention and confiscation of consignments at destination. This approach also helps save the Pakistan’s foreign exchange losses.

The ISO 14000 relates to environmental management to health organizations minimize through operations, which negatively affect the environment. Environmental issues are being dealt with the Ministry of Climate Change.

## Annex 16: 2013/2014 Additions to 2012/2013 Lists of Pakistan Registered Pesticides & Survey of Farm Input (Pesticide) Retail Shops and Bazars

### TABLE 27: 2013/2014 ADDITIONS TO 2012/2013 LIST OF PAKISTAN REGISTERED PESTICIDES

| Sr. No. | Name Of Pesticides | Approved For Use Against |
|---|---|---|
| | **New Pesticides** | |
| 1 | Express 20% SP (Acetamiparid) | Tomato whitefly. |
| 2 | Nexus 25% WP (Imidacloprid) | Brinjal whitefly. |
| 3 | Baran 3% G (Carbofuran) | Sugarcane stem borer. |
| 4 | Danadim Progress 40% EC (Dimethoate) | Cabbage aphid. |
| 5 | Asset 20% SL (Imidacloprid) | Cotton jassid, whitefly, mealy bug. |
| 6 | Capstar 4% G (Cartap Hydrochloride) | Rice stem borer & leaf folder. |
| 7 | Counter 2.5% EC (Deltamethrin) | Cotton spotted bollworm. |
| 8 | Counter Plus 360 EC (Deltamethrin 10 g/l + Triazophos 350 g/l) | Cotton spotted bollworm. |
| 9 | Demand Ultra 10% EC (Lambda – Cyhalothrin) | Cotton spotted bollworm. |
| 10 | Limit 440 EC (Profenofos 400 g/l + Cypermethrin 40 g/l) | Cotton spotted bollworm & mealy bug. |
| 11 | Punch 70% WDG (Imidacloprid) | Cotton jassid, thrips & mealy bug. |
| 12 | Smart 33% WDG (Imidacloprid 30% + Lambda – Cyhalothrin 3%) | Cotton spotted bollworm, thrips & mealy bug. |
| 13 | Spark Ultra 5% EC (Emamectin Benzoate) | Cotton spotted bollworm, American bollworm. |
| 14 | Lesenta 80% WG (Fipronil 400 g/kg + Imidacloprid 400 g/kg) | Cotton jassid & thrips, Sugarcane termites. |
| 15 | Movento Energy 480 SC (Imidacloprid 360 g/l + Spirotetramat 120 g/l) | Cotton jassid, whitefly & mealy bug. |
| 16 | Bracket 70% WS (Imidacloprid) | Cotton jassid & thrips, Maize shoot fly. |
| 17 | Equator 14.5% SC (Indoxacarb) | Diamond back moth (Plutella xylostella) of Cauliflower, Tomato fruit borer. |
| 18 | Flyer 80% SP (Trichlorfon) | Cotton mealy bug, melon fruit fly, guava fruit fly. |
| 19 | Helb Star 20% EC (Pyridaben) | Cotton mites. |
| 20 | Verdict 52% EC (Profenofos 50% + Lambda – Cyhalothrin 2%) | Cotton mealy bug and spotted bollworm. |
| 21 | Route 57% EC (Malathion) | Cotton mealy bug. |
| 22 | Refree 5% SC (Fipronil) | Cabbage diamond back moth & Cotton thrips |

| | | |
|---|---|---|
| 23 | Refree 0.3% G (Fipronil) | Maize stem borer & Rice stem borer. |
| 24 | Contest 25% WDG (Thiamethoxam) | Cotton jassid & okra jassid. |
| 25 | Contest 70% WS (Thiamethoxam) | Cotton jassid, thrips, whitefly & Maize shoot fly. |
| 26 | Tempest 3% G (Phorate) | Maize stem borer. |
| 27 | Gallop 25% WP (Azocyclotin) | Cotton mites & chilies bud mites. |
| 28 | Pyramid 10% AS (Nitenpyram) | Cotton & okra jassid, Cotton thrips. |
| 29 | Pyramid 50% WDG (Nitenpyram) | Cotton jassid. |
| 30 | Refree 56% FS (Fipronil) | Maize shoot fly. |
| 31 | Pronto 70% WG (Imidacloprid) | Cotton jassid, thrips, whitefly. |
| 32 | Rider 1.9% EC (Emamectin Benzoate) | Cotton spotted bollworm, armyworm. |
| 33 | Zox 5% EC (Hexythiazox) | Brinjal mites. |
| 34 | Trizone 40% EC (Triazophos) | Cotton spotted bollworm. |
| 35 | Pronet 50% EC (Profenofos) | Cotton armyworm. |
| 36 | Phase 30% EC (Etofenprox) | Potato jassid. |
| 37 | Couple 4% ME (Emamectin Benzoate 0.6% + Hexaflumuron 3.4%) | Cabbage diamond back moth. |
| 38 | Out Fit 36% WDG (Acetamiprid) | Cotton jassid, thrips, whitefly. |
| 39 | Prudent 25% WP (Azocyclotin) | Cotton mites. |
| 40 | Adder 36% EC (Deltamethrin 1% + Triazophos 35%) | Cotton spotted bollworm. |
| 41 | Gallant 10% WP (Lambda – Cyhalothrin) | Cotton spotted bollworm. |
| 42 | Lancer 10% EC (Lambda – Cyhalothrin) | Cotton spotted bollworm. |
| 43 | Spear 25% WP (Buprofezin) | Cotton whitefly. |
| 44 | Dermot 20% SP (Acetamiprid) | Cotton jassid, thrips, whitefly. |
| 45 | Dermot 20% SL (Acetamiprid) | Cotton jassid, thrips, whitefly. |
| 46 | Coredor 75% SP (Acephate) | Cotton jassid, thrips. |
| 47 | Regent 80% WG (Fipronil) | Sugarcane termites, borers, Maize stem borer, Rice stem borers & plant hoppers. |
| 48 | Poncho Sol 27.1% FS (Clothianidin 111 g/l + Methiocarb 160 g/l) | Maize shoot fly & bird repellent. |
| 49 | Movento 240 SC (Spirotetramat | Cotton whitefly & mites. |
| 50 | Voliam Flexi 300 SC (Chlorantraniliprole 10% + Thiamethoxam 20%) | Brinjal fruit borer, shoot borer, Potato American bollworm, armyworm, Okra American bollworm, spotted bollworm, Tomato fruit borer, Cauliflower / Cabbage diamond back moth. |
| 51 | Bono 20% SL (Acetamiprid) | Cotton jassid, thrips, whitefly & mealy bug. |
| 52 | Best 25% WP (Imidacloprid) | Cotton jassid, thrips & whitefly. |
| 53 | Prado 25% WP (Buprofezin) | Cotton whitefly. |

| | | |
|---|---|---|
| 54 | Lotus 2.5% EC (Lambda – Cyhalothrin) | Cotton spotted bollworm. |
| 55 | Malatox 57% EC (Malathion) | Cotton thrips & mealy bug. |
| 56 | CapRice 5% EC (Chlorfluazuron) | Cotton armyworm. |
| 57 | Gold 1.8% EC (Abamectin) | Cotton spotted bollworm. |
| 58 | Rubin 2.5% EC (Deltamethrin) | Cotton spotted bollworm. |
| 59 | Proaxis 60 CS (Gamma Cyhalothrin) | Cotton thrips, spotted bollworm, pink bollworm, armyworm & Rice leaf folder. |
| 60 | XDE-175 12% SC (Spinetoram) (New Name Radiant) | Cauliflower diamond back moth. |
| 61 | Victory 25% SC (Pymetrozine) | Cotton jassid, thrips & whitefly. |
| 62 | Okill 5% EC (Hexythiazox) | Cotton mites. |
| 63 | Commando Plus 97% DF (Acephate | Maize shoot fly, Cotton thrips & jassid. |
| 64 | Weapon 40% EC (Methidathion) | Cotton mealy bug. |
| 65 | Progress 10% WDG (Lambda – Cyhalothrin) | Cotton spotted bollworm & pink bollworm. |
| 66 | Silent 5% EC (Lufenuron) | Cotton armyworm, Cabbage diamond back moth. |
| 67 | Current 15% EC (Pyridaben) | Cotton mites. |
| 68 | Arrange 50% WDG (Acetamiprid) | Cotton jassid, thrips & whitefly. |
| 69 | Dilute Super 10% G (Monomehypo) | Rice stem borer. |
| 70 | Remand 3% G (Carbofuran) | Maize stem borer. |
| 71 | Mintox Super 10% G (Monomehypo) | Rice stem borer. |
| 72 | Mintox 5% G (Monomehypo) | Rice stem borer. |
| 73 | Cusic 8% G (Cartap Hydrochloride | Rice stem borer. |
| 74 | Dilute 5% G (Monomehypo) | Rice stem borer. |
| 75 | Dorsal 3% G (Carbofuran) | Maize stem borer. |
| 76 | Platinum 36% EC (Deltamethrin 1% + Triazophos 35%) | Cotton spotted bollworm, pink bollworm, American bollworm. |
| 77 | Tracer 24% SC (Spinosad) | Brinjal fruit borer, Cauliflower diamond back moth. |
| 78 | Garner 48% SC (Thiacloprid) | Cotton aphid & whitefly. |
| 79 | Steer 10% WDG (Chlorfenapyr) | Cotton thrips, Brinjal mites. |
| 80 | Steer Plus 10.5% SC (Chlorfenapyr 10% + Emamectin Benzoate 0.5%) | Cotton thrips. |
| **New Herbicides** | | |
| 1 | Panida Grande 43.5% EC (Pendimethalin) | Cotton Broad leaf weeds, grasses & sedges and Potato Broad leaf weeds & grasses i.e., dumbi sittie & madhana as pre post emergence, Onion & peas Broad leaf weeds, grasses & sedges. |
| 2 | Glider 41% SL (Glyphosate) | Annual & perennial weeds in Citrus. |
| 3 | Prowl 50% WP (Isoproturon) | Broad leaf weeds and grasses in |

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| | | Wheat as post emergence. |
| 4 | Retard 70% WP (Metribuzin) | Broad leaf weeds and grasses in Potato. |
| 5 | Spike 15% WP (Clodinafop Propargyl) | Wild oats and Phlaris minor as post emergence in Wheat. |
| 6 | Sulfon 75% WG (Sulfosulfuron) | Broad leaf weeds & narrow leaf weeds in Wheat. |
| 7 | Swift 6.9% EW (Fenoxaprop – P - Ethyl) | Narrow leaf weeds in Wheat. |
| 8 | Equip 2.25% OD (Foramsulfuron) | Grasses, Broad leaf weeds & sedges as early post emergence in Maize. |
| 9 | Buke 70% WP (Metribuzin) | Potato Broad leaf weeds, Wheat Broad leaf weeds. |
| 10 | Atramax 38% SC (Atrazine) | Maize Broad leaf weeds & grasses. |
| 11 | Terminator 10% WP (Pyrazosulfuron Ethyl) | Rice Broad leaf weeds & sedges as pre emergence. |
| 12 | Quintal 960 EC (Metolachlor) | Maize Broad leaf weeds & grasses as post emergence, Cotton Broad leaf weeds, grasses & sedges. |
| 13 | Quantum 20% SL (Paraquat) | Potato Broad leaf weeds, sedges and grasses as post emergence, Citrus annual & perennial weeds. |
| 14 | Torrent 50% WDG (Terbutryn 15% + Terbuthylazine 35%) | Potato Broad leaf weeds & grasses. |
| 15 | Partner 75% WDG (Nicosulfuron) | Maize Broad leaf weeds & grasses. |
| 16 | Herb – D 80% WP (2-4, D Sodium Salt) | Broad leaf weeds in Wheat & Maize. |
| 17 | Hold Up 95% SG (Glyphosate Isopropyl Ammonium) | Citrus annual & perennial weeds. |
| 18 | Cobber 10% WP (Pyrazosulfuron Ethyl) | Broad leaf weeds sedges as early post emergence in Rice. |
| 19 | Conquest 24% EC (Lactofen) | Broad leaf weeds in Cotton. |
| 20 | Emphatic (344 + 120 g/l) AS (2,4-D + Dicamba) | Wheat broad leaf weeds. |
| 21 | Vipex Star 41% WDG (Isoproturon 40% + Tribenuron Methyl 1%) | Wheat Broad leaf weeds & grasses. |
| 22 | Harvester 500 EC (Fluroxypyr 10% + MCPA 40%) | Wheat & Maize Broad leaf weeds. |
| 23 | Hadaf 24% EC (Oxyfluorfen) | Onion Broad leaf weeds & grasses. |
| 24 | Clearfield Extra 20.5% WDG (Fluroxypyr 12.3 g/l + Clopyralid 8.2 g/l) | Maize Broad leaf weeds. |
| 25 | Field Guard 75% WDG (Sulfosulfuron) | Wheat Broad leaf weeds & grasses. |
| 26 | Terminator Extra 10% WDG (Pyrazosulfuron Ethyl) | Rice Broad leaf weeds, grasses & sedges. |
| 27 | Certain 80% WDG (Tralkoxydim) | Wheat grass weeds (Wild oats and Phlaris minor) as post emergence. |
| 28 | Avena Star 30% WDG (Clodinafop Propargyl) | Wheat grass weeds except Bromus as post emergence. |
| 29 | Clincher 60% EC (Bromoxynil 20% + MCPA 40%) | Maize broad leave weeds as post emergence. |

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| 30 | Nominee 100 SC (Bispyribac Sodium) | Rice Broad leaf weeds, grasses & sedges. |
| 31 | Sonak 15% WP (Clodinafop Propargyl) | Wheat grass weeds. |
| 32 | Twister 48% EC (Butralin) | Cotton Broad leaf weeds & grasses. |
| 33 | Cyclon 8% OF (Nicosulfuron) | Maize Broad leaf weeds (Itsit, Tandla and Jangli Palak as post-emergence). |
| 34 | Purge 75% WDG (Thifensulfuron Methyl) | Maize Broad leaf weeds. |
| 35 | Astral 20% WP (Bispyribac Sodium) | Rice Broad leaf weeds, grasses & sedges. |
| 36 | Clover 10% SC (Bispyribac Sodium) | Rice Broad leaf weeds, grasses & sedges. |
| 37 | Opal 90% WDG (Atrazine) | Sugarcane Broad leaf weeds. |
| 38 | Zip Up 42% EC (Acetochlor 25% + Pendimethalin 17%) | Cotton Broad leaf weeds & grasses. |
| 39 | Clean Up 48% SL (Glyphosate) | Citrus annual & perennial weeds. |
| 40 | Herbstar 60% EC (Bromoxynil 30% + MCPA 30%) | Wheat Broad leaf weeds. |
| 41 | Cutter 15% WP (Clodinafop Propargyl) | Wheat grass weeds. |
| 42 | Weed Out 40% SE (Atrazine 16% + Propisochlor 24%) | Maize Broad leaf weeds & grasses. |
| 43 | Marter 80% WP (Ametryn 40% + Atrazine 40%) | Sugarcane Broad leaf weeds & grasses. |
| 44 | Welazin 38% SC (Atrazine) | Maize Broad leaf weeds. |
| 45 | Lancelot Star 15% EO (Fluroxypyr Meptyl 14% + Aminopyralid Triisoprop anolammonium) | Wheat broad leaves. |
| 46 | Starane M 50 EC (Fluroxypyr 100 g/l + MCPA 400 g/l) | Wheat broad leaf weeds. |
| 47 | Mark 60% EC (Butachlor) | Rice broad leaves weeds. |
| 48 | Canmore 78% WP (AM002) (Bromoxynil 65% + Ametryn 13%) | Sugarcane Broad leaf weeds, grasses & sedges. |
| 49 | Morewise 40% SP (Bromoxynil 20% + MCPA 20%) | Wheat Broad leaf weeds. |
| 50 | Atlantis Super 6% WG (Mesosulfuron Methyl 30 g/kg + Iodosulfuron Methyl Sodium 30 g/kg) | Wheat Broad leaf weeds & grasses as post emergence. |
| | **New Fungicides** | |
| 1 | Contaf Plus 051 SC (Hexaconazole) | Muskmelon powdery mildew, Mango powdery mildew, apple powdery mildew & Rice sheath blight. |
| 2 | Chloronil 75% WP (Chlorothalonil) | Tomato & Potato late blight & downy mildew of muskmelon. |
| 3 | Feast – M 72% WP (Metalaxyl 8% + Mancozeb 64%) | Downy mildew of muskmelon, collar rot of chili, downy mildew of cucumber & Tomato late blight. |
| 4 | Metacarb 25% WP (Metalaxyl 15% + Propamocarb Hydrochloride10%) | Downy mildew of cucumber & muskmelon, Tomato late blight. |
| 5 | Toss 50% WDG (Dimethomorph) | Potato late blight. |

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| 6 | V – Nurse 70% WP (Fosetyl Aluminium 30% + Mancozeb 40%) | Tomato late blight, collar rot of chili, downy mildew of cucumber & muskmelon. |
| 7 | Ridomil Gold MZ 68 WG (Mefenoxam 4% + Mancozeb 64%) | Potato late blight, downy mildew of Onion, tobacco, melon, cucumber, Citrus gummosis. |
| 8 | Fork 6% WP (Kasugamycin) | Rice blast. |
| 9 | Protocol 50% WP (Chlorothalonil 33.3% + Procymidone 16.7%) | Melon downy mildew. |
| 10 | Rely 40% WP (Myclobutanil) | Powdery mildew in bitter gourd. |
| 11 | Epic 12.5% SC (Epoxiconazole) | Powdery mildew in bitter gourd. |
| 12 | Netzschwefel stulln 80% DF (Sulfur) | Powdery mildew of cucumber. |
| 13 | Proctor Plus 50% EC (Difenoconazole 25% + Propiconazole 25%) | Late blight of Potato. |
| 14 | Kocide 3000 52.4% WG (Copper Hydroxide) | Potato late blight & early blight. |
| 15 | Flumax 60% EC (Metalaxyl-M 20% + Fluazinam 40%) | Potato late blight. |
| 16 | Claim 80% WP (Thiram) | Okra root rot. |
| 17 | Pyrine 25% WP (Pyrimethanil) | Potato late blight. |
| 18 | Pick It 80% WDG (Fosetyl Aluminium) | Potato late blight. |
| 19 | Copper Blue 5% WSC (Copper Ammonium Carbonate) | Potato late blight (Phytophthora infestans). |
| 20 | Folio Gold 440 SC (Chlorothalonil 40% + Metalaxyl-M 4%) | Potato early & late blight, Onion & cucumber downy mildew. |
| 21 | Triger 25% EC (Tebuconazole) | Potato late blight. |
| 22 | Valvet 80% WDG (Fosetyl Aluminium) | Potato late blight. |
| 23 | Index 76% WP (Cymoxanil 6% + Propineb 70%) | Tomato early blight & Potato late blight. |
| 24 | Spore Off 75% WP (Tricyclazole) | Rice blast. |
| 25 | Spectrum 30% EC (Difenoconazole 15% + Propiconazole 15%) | Potato early & late blight. |
| 26 | Raxil Ultra 12% FS (Tebuconazole) | Wheat loose smut. |
| 27 | Treaty 6% ME (Tebuconazole) | Long gourd powdery mildew. |
| **Label Expansions:** | | |
| **Pesticides** | | |
| 1 | Buster 20% SP (Acetamiprid) | Cotton mealy bug. |
| 2 | Buster 20% SL (Acetamiprid) | Cotton thrips, whitefly & mealy bug. |
| 3 | Sharp 25% WP (Imidacloprid) | Cotton jassid, thrips, whitefly & mealy bug. |
| 4 | Tender 10% EC (Bifenthrin) | Cotton spotted bollworm & mealy bug. |
| 5 | Confidor 200 SL (Imidacloprid) | Onion thrips. |
| 6 | Actara 25 WG (Thiamethoxam) | Chili aphids (Myzus pursicae). |
| 7 | Border 61.5% EC (Profenofos 600 g/l + Lambda – | Cotton armyworm, pink bollworm, |

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| | Cyhalothrin 15 g/l) | jassid, thrips, whitefly. |
| 8 | Result 55% EC (Profenofos 500 g/l + Cypermethrin 50 g/l) | Cotton pink bollworm. |
| 9 | Gold Star 20% EC (Bifenthrin 10% + Pyridaben 10%) | Cotton armyworm, pink bollworm, jassid, thrips, whitefly. |
| 10 | Resham 10% EC (Bifenthrin) | Mango hopper. |
| 11 | Talent 48% SC (Thiacloprid) | Cotton jassid, thrips, whitefly, Potato aphid. |
| 12 | Escort 70% WDG (Imidacloprid) | Cotton jassid. |
| 13 | Unique – M 5% SC (Fenpyroximate) | Apple mites & chilies bud mites. |
| 14 | Coragen 20% SC (Chlorantraniliprole) | Cauliflower diamond back moth, Tomato fruit borer, okra American bollworm, spotted bollworm. |
| 15 | Resham Plus 11.5% EC (Bifenthrin 8.7% + Abamectin 2.8%) | Cotton jassid, thrips, whitefly. |
| 16 | Binder 48% FS (Imidacloprid) | Cotton mealy bug. |
| 17 | Disciplin 13.3% EC (Abamectin 4.3% + Imidacloprid 9.0%) | Cotton jassid, thrips. |
| 18 | Novastar 56 EC (Bifenthrin 50 g/l + Abamectin 6.25 g/l) | jassid in mung bean. |
| 19 | Tracer 48% SC (Spinosad) (New name Spintor) | Musk melon leaf miner, Cauliflower diamond back moth. |
| **Herbicides** | | |
| 1 | Razor 33% EC (Pendimethalin) | Broad leaf weeds in Cotton. |
| 2 | Logran 75 WG (Triasulfuron) | Broad leaf weeds, grasses & sedges in Rice. |
| 3 | Delux 20% SL (Paraquat) | Potato Broad leaf weeds, grasses & sedges. |
| 4 | Percept 10.8% EC (Haloxyfop – P – Methyl) | Brinjal grass weeds as post emergence. |
| **Fungicides** | | |
| 1 | Nativo 75% WG (Trifloxystrobin 250 g/kg + Tebuconazole 500 g/kg) | Mango anthracnose and powdery mildew. |
| 2 | Armure 300 EC (Propiconazole 150 g/l + Difenoconazole 150 g/l) | For use against Rice blast (pyricularia oryzae). |
| 3 | Score 250 EC (Difenoconazol) | Moong blight (Ascochyta phescolorum), moon leaf spot. |
| **Locally Manufactured In Pakistan** | | |
| 1 | Explorer 1.9% EC (Emamectin Benzoate) | Cotton American bollworm, armyworm, Potato American bollworm, armyworm, Cabbage diamond back moth. |
| 2 | Explorer 5% WDG (Emamectin Benzoate) | Cotton American bollworm, |

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| | | armyworm, Potato Helicoverpa armigera, armyworm, Cabbage diamond back moth. |
| 3 | Explorer 5% EC (Emamectin Benzoate) | Cotton American bollworm, armyworm, Potato American bollworm, armyworm, Cabbage diamond back moth. |
| 4 | Momentum 50% WDG (Chlorfenapyr 30% + Nitenpyram 20%) | Cotton jassid, thrips, mites. |
| 5 | Pyranex 30% WDG (Bispyribac Sodium 18% + Bensulfuron methyl 12%) | Rice broad leave weeds, grasses & sedges. |
| 6 | Lynex 75% WDG (Linuron) | Potato broad leaf weeds & grasses. |
| 7 | Top Max 960 EC (Metolachlor 83% + Pendimethalin 13%) | Cotton broad leaf weeds & grasses. |
| 8 | Horizon 90% EC (Acetochlor) | Maize grasses & Broad leaf weeds. |
| 9 | Wheat Star 66% WDG (Clopyralid 30% + Fluroxypyr Meptyl 30% + Tribenuron Methyl 6%) | Wheat Broad leaf weeds. |
| 10 | Metafin Super 28.6% WDG (Metsulfuron 14.3% + Tribenuron Methyl 14.3%) | Wheat Broad leaf weeds. |
| 11 | Dominate Gold 88.8% WSG (Glyphosate) | Broad leaf weeds, grasses & sedges in lemon. |
| 12 | Clearfield Gold 75% WDG (Clopyralid) | Wheat Broad leaf weeds. |
| 13 | Chlorguard 10% G (Chlorpyrifos) | Maize borer. |

## Survey Of Farm Input (Pesticide) Retail Shops and Bazars

The visit was conducted to record that which of the registered (2012-13) pesticides were present at the pesticide dealer's shops, and records other (illegal, not registered) pesticides that were also present. The visit was performed in the province of Punjab, Sindh and KPK covering about 150 farm input retail shops. The Baluchistan province was not visited due to security situation. The survey/visit methodology was the informal/formal according to questioner provided by Dr. Alan. The salient results of the survey are as follows;

- Most of the pesticide shops were out of stock or less on stock because the peak season of pesticide usage and availability is in the targeted crop season (July-Sep).
- Majority of the products were sold for the crops and pests mentioned on label and used according to the label instructions.
- Almost all the farm input shops mentioned that when a new product is launched, the effectiveness is 100%, however, after the passage of time effectiveness decrease.
- It was commonly mentioned by the farmers that doses on each product label is followed, however, if attack is high, then dose is increased depending on the condition of crops and pest attack.
- During the survey it was noticed that in majority of cases no expiry pesticides were found in Punjab. In case of expired products it was mentioned that, the product is not for sale. It was also reported by farm input suppliers that 5-6 months before expiry date product is returned to the company. However, if any product is expired on farmer's end, then farmer is responsible.

- In Sindh and KPK, it was generally observed that the dealers have no basic knowledge about pesticide product stewardship. They are selling it as poison for any pest and any crop.
- Lack of basic knowledge of hazardous effects.
- Overall no precautionary measures were taken for the safety.
- In Sindh it was also observed that a few dealers also kept expired pesticides in the shop. It may be strongly assumed that they are selling it to end users who are illiterate and not able to read the label on pesticide container, they depend on shop keepers.
- When asked to dealers how the expired pesticides and used containers are disposed of, the frequent reply was that they never disposed any pesticides but give the pesticides on minimized cost to any poor or needy farmer.
- In Sindh, it was also observed some pesticides which were not permitted by Department, like Magic-C and Elegant super are being sold in the market.

### TABLE 28: LIST OF REGISTERED PESTICIDES THAT WERE PHYSICALLY PRESENT AT FARM INPUT SHOPS

| List of Registered Pesticides Present at Various Shops | | |
|---|---|---|
| **Pesticide Name** | **Pesticide Name** | **Pesticide Name** |
| Stomp 455CS | FMC | PAK/APO/543/2003 |
| Advantage 20% EC | FMC | PAK/APO/247/85 |
| Acrobat MZ | FMC | PAK/APO/619/2007 |
| Platform | FMC | (Generic)/DPP/2008(3440) |
| Vitara | FMC | (Generic)/DPP/2007(2950) |
| Emamectin Benzoate 1.9 EC | FMC | (Generic)/DPP/2005(2362) |
| Marshal 5% EC | FMC | (Generic)/DPP/2010(3978) |
| Acelon 20% SL | FMC | (Abroad)/DPP/2002(979) |
| Talstar 10% EC | FMC | PAK/APO/267/87 |
| Confedor | Bayer | PAK/APO/245-A/92 |
| Simida 25% (w/w)WP | Jaffer | PAK/APO/627/2008 |
| Imidaclopard | Plant 4 Life | (Generic)/DPP/2011(4644) |
| Rosplan | Welcon | (Generic)/DPP/2007(2901) |
| Metlexil + Minkozel | Solex | (Generic)/DPP/2009(3842) |
| Triclorfin | Solex | (Generic)/DPP/2008(3396) |
| Thiophanate methyl | Believers Internl | (Generic)/DPP/2011(4612) |
| Ladder | Welcon | (Generic)/DPP/2003(1525) |
| Lufenuron | Believers Internl | (Generic)/DPP/2011(4438) |
| Imidacloprid 70 WS | Believers Internl | (Generic)/DPP/2005(3257) |
| Hasper | Welcon | (Generic)/DPP/2007(2922) |
| Acephate | Plant 4 Life | (Generic)/DPP/2012(4706) |
| Garner 48% SC | Ag Pharma | PAK/APO/701/2010 |
| Sitrol Plus 30% SC | Ag Pharma | (Abroad)/DPP/2013(1634) |

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| Rector 5% SC | Ag Pharma | (Generic)/DPP/2011(4596) |
| Flute 10.8% EC | Ag Pharma | (Abroad)/DPP/2007(1107) |
| Quintal 960 EC | Ag Pharma | PAK/APO/764/2012 |
| Combinex 45 DP | Ag Pharma | (Abroad)/DPP/2012(1444) |
| Steer 10 WDG | Ag Pharma | PAK/APO/760/2012 |
| HALT 75% WDG | Ag Pharma | (Abroad)/DPP/2012(1464) |
| Prenil 40% WP | Ag Pharma | PAK/APO/839/2013 |
| Projib | Ag Pharma | PB/FCO/DSF(786-5221)/ Y2K12 |
| Confidor 20% SL | Bayer | PAK/APO/425-B/92 |
| Concept 10.8 EC | Ag Pharma | (Generic)/DPP/2011(4531) |
| Oberon 24% SC | Bayer | (Abroad)/DPP/2007/1100 |
| Confedor 70% SC | Bayer | PAK/APO/425-A/92 |
| Bay Folan 8-8-6 | Bayer | PB/FCD/DSF(786/2885)/ y2k13 |
| Nativo 75%WG | Bayer | PAK/APO/628/2008 |
| Planrofix | Bayer | PB/FCD/DSF(786-1119) y2k11 (Renew) |
| Regint 80% WG | Bayer | PAK/APO/826/2012 |
| Honsbro 18.625% FC | Bayer | (Abroad)/DPP/2007/1114 |
| Melodi Dew 66.8% WP | Bayer | PAK/APO/676/2009 |
| Emmamectin Benzonate 1.9% EC | Farmer Friends (FF) | (Generic)/DPP/2008/3424 |
| Nexus-SL 20% SL | Sawat Agro | (Generic)/DPP/2009/3770 |
| Pirate 360 | Sawat Agro | PAK/APO/487/99 |
| Cyren 4E | Sawat Agro | PAK/APO/606/2007 |
| Top Guard 30% SC | Sawat Agro | (Abroad)/DPP/2012/1553 |
| Index 5% EC | Welcon | (Generic)/DPP/2010/4108 |
| Mine Guard 50% WP | Welcon | (Abroad)/DPP/2004/1053 |
| Imidacloprid 20%SL | Farmer Friends (FF) | (Generic)/DPP/2008/3384 |
| PyriProxyfen 10.8%EC | Farmer Friends (FF) | (Generic)/DPP/2011/4531 |
| Bifenthrin 10% EC | Plant 4 Life | (Generic)/DPP/2011/4651 |
| Dividend (Star) 036 FS | Syngenta | PAK/APO/674/2009 |
| Proclaim 019EC | Syngenta | PAK/APO/557/2004 |
| Polytrine C 440EC | Syngenta | PAK/APO/190/82 |
| Match 050 EC | Syngenta | PAK/APO/495/2000 |
| Axial XL050 EC | Syngenta | (Abroad)/DPP/2010/1239 |
| Karate 2.5EC | Syngenta | PAK/APO/258/87 |
| Imidacloprid 20%SL | Syngenta | (Generic)/DPP/2009/3620 |
| Curacren 500EC | Syngenta | PAK/APO/191/82 |
| Dual Gold 960 EC | Syngenta | PAK/APO/527/2003 |
| Imidacloprid 20% SL | FMC | (Generic)/DPP/2006(2737) |
| Pursue 25% EC | FMC | (Generic)/DPP/2009(3915) |

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| Advantage 20% EC | FMC | PAK/APO/247/85 |
| Bestox 5% EC | FMC | PAK/APO/268/87 |
| Marshal 5% EC | FMC | (Generic)/DPP/2010/3976 |
| Novastar 56 EC | FMC | PAK/APO/532/2003 |
| Talstar 10% EC | FMC | PAK/APO/267/87 |
| Cabrio Top 60% WDG | FMC | (Abroad)/DPP/2007/1112 |
| Acrobat MZ 90/600 WP | FMC | PAK/APO/619/2007 |
| Galaxy 48% SL | FMC | (Generic)/DPP/2008/3281 |
| Metric 25% ZC | FMC | (Abroad)/DPP/2009/1151 |
| AcetoClor 50% EC | Farmer Friends (FF) | (Generic)/DPP/2010/4173 |
| ImidaClopard 25% WP | Agrozat | (Generic)/DPP/2010/4330 |
| ParaQuat 20% SL | Nice International | (Generic)/DPP/2012/4714 |
| Emmamactin 1.9% EC | Nice International | (Generic)/DPP/2008/3424 |
| Bifenthrin 10% EC | Nice International | (Generic)/DPP/2010/3987 |
| Nathan 36% SC | Sayban | (Generic)/DPP/2011/4619 |
| Pyriproxyfen | Farm Eco | (Generic)/DPP/2011/4516 |
| Glyphosate 48% W/V | Ittefaq Chemical Group | PAK/APO/708/2010 |
| Super Lambeda 10% EC | Agro Mart | PAK/APO/654/2009 |
| Stenza 25% EC | Agro Mart | (Generic)/DPP/2007/3082 |
| G Litter 20% SL | Agro Mart | PAK/APO/646/2008 |
| Bestow 80% SP | Agro Mart | (Generic)/DPP/2004/2099 |
| Bruce 10.8% EC | Agro Mart | (Abroad)/DPP/2010/1171 |
| Artist 70% WS | Agro Mart | (Generic)/DPP/2007/2890 |
| Salute 10% EC | Agro Mart | (Generic)/DPP/2003/1558 |
| WelFos 40%EC | Agro Mart | PAK/APO/653/2009 |
| Striker 25% WP | Solex | (Generic)/DPP/2001/908 |
| Emmamectin 5% WDG | Solex | (Generic)/DPP/2009/3895 |
| Matalaxyl 72% WP | Solex | (Generic)/DPP/2009/3842 |
| Agrzole 75% WP | Solex | (Abroad)/DPP/2010/1184 |
| Lambda 2.5% EC | Croplands | (Generic)/DPP/2010/4043 |
| ParaCot 20 SL | Croplands | (Generic)/DPP/2011/4615 |
| Smasher 1.9% EC | Economy Pesticides | (Generic)/DPP/2009/3872 |
| Hornet 10% EC | Al-Hamad Agro | (Generic)/DPP/2009/3606 |
| Lufenuron 5% EC | Al-Hamad Agro | (Generic)/DPP/2010/4107 |
| Decis 2.5% EC | Bayer | PAK/APO/133/79 |
| Cashier 20% SL | Economy Pesticides | (Generic)/DPP/2009/3384 |
| PyriProxyfen 10.8% EC | Farm Evo | (Generic)/DPP/2012/4849 |
| Acetochlor 50% EC | Al-Hamad Agro | (Generic)/DPP/2011/4406 |
| Glyphosate 48% SL | National Chemicals | (Generic)/DPP/2009/3557 |
| Section 10.8% E | National Chemicals | (Generic)/DPP/2012/4745 |

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| Lufenuron 5% EC | National Chemicals | (Generic)/DPP/2010/4018 |
| Solution 50% WP | Agri Farm | (Abroad)/DPP/2010/1243 |
| GamaFas 40% EC | Agri Farm | (Generic)/DPP/2009/3522 |
| Emabe 4% EC | Agri Farm | (Abroad)/DPP/2011/1377 |
| Pinky 70% WS | Agri Farm | (Generic)/DPP/2006/2679 |
| Lance Plus 11% WP | Agri Farm | (Abroad)/DPP/2013/1632 |
| Bloom Star 40% EC | Agri Farm - Aziz Group | (Abroad)/DPP/2010/1280 |
| Bifenthrin 10% EC | KSE | (Generic)/DPP/2011/4651 |
| Deltamethrin 2.5% EC | National Chemicals | (Generic)/DPP/2007/2891 |
| AnPon 25% WP | Agri Farm | (Abroad)/DPP/2010/1285 |
| Acetamiprid | National Chemicals | (Generic)/DPP/2007/2876 |
| Volume Flaxy 300 SC | Syngenta | PAK/APO/781/2012 |
| Match 050 EC | Syngenta | PAK/APO/495/2000 |
| Polytrin C 440 EC | Syngenta | PAK/APO/190/82 |
| Proclaim | Syngenta | PAK/APO/557/2004 |
| CuraCron 500 EC | Syngenta | PAK/APO/191/82 |
| Karate 2.5 EC | Syngenta | PAK/APO/258/87 |
| Alliette 80% WP | Bayer | (Abroad)/DPP/93/34 |
| Tecammin Max | AgriTecno | PB/FCO/DSF(786-2205)y2k9 |
| Nativo 75% WG | Bayer | PAK/APO/628/2008 |
| Contaf Plus 5.1% (W/V)SC | Confidor 20% SL | PAK/APO/425-B/92 |
| Bloom 25 EC | Kanzo Ag | (Abroad)/DPP/2009/1141 |
| Reform 10 EC | Pak China Chemical | (Generic)/DPP/2000/630 |
| Confidor 20% SL | Bayer | PAK/APO/425-B/92 |
| Evict 2.5 EC | Envoyl Ag Pharma | (Generic)/DPP/2010/4008 |
| Quintal 960 EC | Envoyl Ag Pharma | PAK/APO/764/2012 |
| Track 10% EC | Target | PAK/APO/673/2009 |
| Cernez 10.8 Ec | Target | (Abroad)/DPP/2010/1193 |
| Timer 5 EC | Target | PAK/APO/569/2006 |
| Check 25% EC | Target | (Abroad)/DPP/2012/1527 |
| Parcel 20 WP | Target | (Abroad)/DPP/2010/1195 |
| Tegula 2.5 EV | Target | (Abroad)/DPP/2006/1081 |
| Saomanjing 15 EC | Target | (Abroad)/DPP/2003/992 |
| Capital Plus 417 EC | Target | PAK/APO/625/2008 |
| Crown 70 WS | Target | PAK/APO/534/2003 |
| Leopard | Target | PAK/APO/523/2003 |
| Goldstar | Target | PAK/APO/754/2010 |
| Finder | Target/Ali Akbar | (Generic)/DPP/2011/4461 |
| Progress | Target/Ali Akbar | (Generic)/DPP/2011/4516 |
| Scotts | Agrow | (Abroad)/DPP/2012/1537 |

| | | |
|---|---|---|
| Imidacloparid 20 SL | Patron | (Generic)/DPP/2010/4279 |
| Bifenthrin 10% EC | Patron | (Generic)/DPP/2003/1558 |
| Lambda 2.5% EC | Patron | (Generic)/DPP/2003/1414 |
| Leufeneron 5% Ec | Total Care | (Generic)/DPP/2010/4144 |
| Kalfen 5% EC | Solex | (Abroad)/DPP/2010/1219 |
| Pentor 20% SL | Solex | PAK/APO/723/2010 |
| Perfect 2.5% EC | Solex | (Generic)/DPP/2007/2968 |
| Charm 10% EC | Solex | (Generic)/DPP/2001/920 |
| Striker 25% WP | Solex | (Generic)/DPP/2001/908 |
| S-Phate 75% SP | Solex | (Generic)/DPP/2012/4747 |
| Gaonong 2.5% EC | Solex | (Abroad)/DPP/1998/707 |
| Imidacloparid 25WP | Hafiz Agro | (Generic)/DPP/2008/3425 |
| Thiophenate 70% WP | Hafiz Agro | (Generic)/DPP/2010/4136 |
| Gliphosate 48% SL | Hafiz Agro | (Generic)/DPP/2008/3208 |
| Lambada 2.5% EC | Hafiz Agro | (Generic)/DPP/2010/4243 |
| ChlorPyroFos 40 EC | Hafiz Agro | (Generic)/DPP/2009/3740 |
| Quintal 960% EC | Anza Enterprises | PAK/APO/764/2012 |
| Lufenuron 5% | Farm Evo | (Generic)/DPP/2011/4949 |
| Saphora 100EC | Agro Mart | (Generic)/DPP/2013/5238 |
| PlanoFix | Bayer | PC/FCD/DSF(786-11197) y2k11 (Renew) |
| Diafenoconazole 25% EC | Korean Chemicals | (Generic)/DPP/2007/3054 |
| Emmamectin 1.9% EC | Patron | (Generic)/DPP/2010/3990 |
| Aproach | Patron | (Generic)/DPP/2010/4291 |
| Imidacloparid | Patron | (Generic)/DPP/2010/4279 |
| Lambda | Patron | (Generic)/DPP/2003/1414 |
| DifenoCoraZole 25% EC | Anza EnterPrises | (Generic)/DPP/2007/3076 |
| DifenoCoraZole 25% EC | Trust Agro | (Generic)/DPP/2007/3054 |
| AcetoChlor 50% EC | Hafiz Agro | (Generic)/DPP/2010/3993 |
| Kosher 5% EC | Auriga Point | (Generic)/DPP/2010/4106 |
| Daxlas 100EC | SunCrop | (Generic)/DPP/2012/5003 |
| Systhane 20% EW | FMC | (Abroad)/DPP/2008/1129 |
| Bloom 25EC | Evyol | (Abroad)/DPP/2009/1141 |
| Red Gold | SunCrop | (Abroad)/DPP/2011/1416 |
| Tefluthrin | Syngenta crop | 2012 |
| Abamectin | Syngenta crop | 2012 |
| S-Metolachlor | Syngenta crop | 2012 |
| Mesotrione | Syngenta crop | 2012 |
| Cyper kill | Syngenta crop | 2013 |
| Karate | Syngenta crop | 2013 |

| | | |
|---|---|---|
| Paraquat | Syngenta crop | 2012 |
| Atrazine | Syngenta crop | 2013 |
| Lambda-cyhalothrin | Syngenta crop | 2013 |
| Bifenthrin | FMC corp. | 2013 |
| Bifenthrin | FMC corp. | 2012 |
| Imida cloprid | FMC corp. | 2013 |
| Glaxy | FMC corp. | 2012 |
| Glyphosate 41% SL | Agro Chemicals | 2013 |
| Acetochlor | Universal crop Protection | 2012 |
| Permethrin | Bayer crop science | 2013 |
| Spiromesifen | Bayer crop science | 2012 |
| Imidaclopid | Bio care service | 2012 |
| Cyper methrin | Bio care service | 2012 |
| Lambda | Bio care service | 2012 |
| Chlorpyrifos | Global | 2012 |
| Cyper methrin | Global | 2012 |
| Sulfoxaflor | Dow agro science | 2013 |
| Cyantraniliprole | Dow agro science | 2013 |
| Clothianidin | Valent | 2013 |
| Aceto spud nic-3 ec | Aceto | 2012 |
| Lambda-Cyhalothrin | Nufarm Americas, inc | 2013 |
| Lmidacloprid | Nufarm Americas, inc | 2012 |
| Timer | Target | 2012 |
| Helmet | Target | 2012 |

## TABLE 29: LIST OF UN-REGISTERED PESTICIDES THAT WERE PHYSICALLY PRESENT AT FARM INPUT SHOPS

| List of Un-registered Pesticide Found in Shops | |
|---|---|
| 1 | Prim |
| 2 | Shoulder Plus |
| 3 | Hook |
| 4 | Hi – K |
| 5 | Emamectin Benzoate |
| 6 | Mirage |
| 7 | Beat |
| 8 | Viper |
| 9 | Tenekil |
| 10 | Ranger |

| | |
|---|---|
| 11 | Boxer |
| 12 | Dura flex |
| 13 | Guardian |
| 14 | Tiger |
| 15 | Rondo |
| 16 | Torque |
| 17 | Maladec |
| 18 | **Methamidophos** |
| 19 | **Endosulfan** |
| 20 | Magic-C |
| 21 | Elegant super |

These banned pesticides were mostly used against Cotton Jassids, Thrips, Aphids, Pink boll worm, white fly, Helliothis and others.

### TABLE 30: FARM INPUT SHOPS OWNERS KNOWLEDGE ABOUT THE USES (CROPS, PESTS) FOR EACH CHEMICAL

| Sr. # | Pesticide Name | Uses/ Acre | Remarks |
|---|---|---|---|
| 1. | Imidaclopard | 125gm/Acre | According to the label<br>Usage vary from crop to crop and pest attack<br>Depending on pest attacks and crops |
| 2. | Emamectin | 200gm/Acre | |
| 3. | Asetamipird | 125gm/Acre | |
| 4. | Pyriproxyfen | 400ml/Acre | |
| 5. | Lemda | 330ml/Acre | |
| 6. | Netumperum | 200ml/Acre | |
| 7. | Acifid | 250gm/Acre | |
| 8. | Cloriperifast | | |
| 9. | Deltamethrin | 350ml/Acre | |
| 10. | Biphenthrin | 250-300ml/Acre | |
| 11. | Dual Gold | 800cc/Acre | If Dual Gold use 800cc/Acre, soil hard and growth decrease |
| 12. | All other pesticides use as mention on label | | |

## Disposal of obsolete pesticides and used containers (Farm Input Shop's Response)

- Return to company/manufacturer/formulator. If pesticides expire on farmer's end, also return to company/manufacturer/formulator.

- Return to company/manufacturer/formulator at least 1 to 6 months before and mentioned in stock register.
- "Not For Sale" mentioned on product. Return to company/manufacturer/ formulator.
- No practice to dispose of any pesticide so far. If any pesticides expire then there is no side effect, just only result reduces to 80%.
- Return to company or use at own farm. No practice to dispose of so far.
- No practice ever adopted to dispose of, it is generally thrown into canal or buried under ground.
- Don't know how to dispose-off expired pesticides.

### Farm Input shop/store cleanliness and order (Physical Verification & Shopkeeper Response

- On majority of the shops No Fire Extinguisher was present
- Generally there were poor conditions of cleanliness.
- Mostly all shops were having odor/pesticide smell in the shop.
- In case of leakage/broken container of pesticides, they covered the spilled over chemicals with soil and sand and then that soil/sand is thrown into garbage, desert or nearby crop.

## Annex 17: Pakistan Pesticide Sector Analysis

The involvement of private sector in pesticide activities made this a vibrant business venture. It had far-reaching effects on the overall agriculture of Pakistan. Private companies provided many incentives to farmers including credits and their contact with farmers was far better than provincial Agriculture Extension Departments. It posed pesticides as a single control measure for plant protection against insect pests hence played an important role in increasing over all use of pesticides.

The aggressive media campaigns especially on national television channel at prime time enhanced products promotion and subsequent usage by the farmers. Overall consumption reached a peak in the year 2004 when 129,598 metric tons were consumed. Afterwards the consumption has been reduced significantly and went down up to 40,463 metric tons in 2009 (see Table below). The main reason for this was the reduced pest pressure due to the introduction of resistant varieties, especially of BT cotton and lowering productivity of cotton and other cash crops.

Initially the pesticide business was in the grip of multinational companies, as importers preferred to import their products from manufacturing facilities abroad. Later, however, some local companies emerged and installed formulation facilities with the technical assistance and investment of China. There are currently 98 pesticide manufacturing/formulation plants presently operating in Pakistan. From the year 2000 onward the ratio of import to local manufacturing skewed towards local production.

### TABLE 31: PESTICIDE CONSUMPTION IN PAKISTAN

| Year | Imports (Metric Tons) | Production (Metric Tons) | Total (Metric Tons) |
|---|---|---|---|
| 1982 | 3552 | 1448 | 5000 |
| 1983 | 4875 | 1713 | 6588 |
| 1984 | 6081 | 3132 | 9213 |
| 1985 | 8270 | 4260 | 12530 |
| 1986 | 8834 | 5665 | 14499 |
| 1987 | 8019 | 6829 | 14848 |
| 1988 | 6256 | 6816 | 13072 |
| 1989 | 6869 | 7738 | 14607 |
| 1990 | 4802 | 9941 | 14743 |
| 1991 | 6157 | 14056 | 20213 |
| 1992 | 6691 | 16748 | 23439 |
| 1993 | 6128 | 14151 | 20279 |
| 1994 | 10693 | 14176 | 24869 |
| 1995 | 20134 | 23239 | 43373 |
| 1996 | 24151 | 19068 | 43219 |
| 1997 | 24168 | 13836 | 38004 |
| 1998 | 22765 | 18081 | 40846 |
| 1999 | 27210 | 18470 | 45680 |
| 2000 | 19764 | 41535 | 61299 |

| | | | |
|---|---|---|---|
| 2001 | 20678 | 26914 | 47592 |
| 2002 | 27103 | 42794 | 69897 |
| 2003 | 24028 | 54105 | 78133 |
| 2004 | 40482 | 89116 | 129598 |
| 2005 | 28371 | 76792 | 105164 |
| 2006 | 12721 | 30855 | 43576 |
| 2007 | 17939 | 76326 | 94265 |
| 2008 | 9282 | 29904 | 39186 |

*Source: Agriculture Statistics of Pakistan 2009-10*

### Pakistan pesticide use patterns

Pesticides consumption data suggest that the insecticides comprise of 90% of the total pesticides used in Pakistan followed by herbicides (7%), fungicides (3%) and acaricides & fumigants (0.2%). In 2010 and 2011, the trend continued. Higher insecticide usage is a constant phenomenon of Pakistan's agriculture. Use of herbicides is usually confined to only one application therefore its consumption always remains far low than insecticide use.

With regard to crops, the share of cotton crop is the highest (60.6%) of the total pesticides use in Pakistan followed by fruits and vegetables (11.9 %), wheat (9.7), paddy (8.3%) and sugarcane (4.6 %). Maximum numbers of sprays are carried out on cotton crop followed by fruits & vegetables and paddy (see Table below). Punjab has the highest percentage of pesticide use and 75.3% treated area belongs to this province followed by Sindh (22.4%) owing to high-cropped area in Punjab (see Table below). There is a downward trend of overall pesticide consumption in Punjab and Sindh due to declining use on cotton. However, it is escalating in Khyber Pakhtoonkhwa for the reason of increased use on fruits and vegetables.

**TABLE 32: AREA COVERED BY GROUND PLANT PROTECTION MEASURES (2009-2010)**

| Crop | Spray in hectares (000 ha) | Percent of total spray | No. of spray |
|---|---|---|---|
| Paddy | 2928.8 | 8.3 | 1.5-3 |
| Cotton | 21527.1 | 60.6 | 2-5 |
| Sugarcane | 1639.1 | 4.6 | 1 |
| Maize | 1245.2 | 3.5 | 1 |
| Wheat | 3455.5 | 9.7 | 1 |
| Oilseed | 420.5 | 1.2 | 1-3 |
| Tobacco | 58.6 | 0.2 | 1-3 |
| Fruits/vegetables | 4221.0 | 11.9 | 1-5 |
| Total | 35495.6 | 100.0 | - |

*Source: Agriculture Statistics of Pakistan 2009-10*

**TABLE 33: PROVINCIAL USE OF PESTICIDES**

| Province | Pesticide Spray (000 ha) | Percent of Total |
|---|---|---|
| Punjab | 27220.1 | 75.3 |
| Sindh | 8098.5 | 22.4 |
| Khyber Pukhtunkhwa | 647.3 | 1.8 |
| Balochistan | 177 | 0.5 |
| Pakistan | 34495.6 | 100.0 |

*Source: Agriculture Statistics of Pakistan 2009-10*

### Pakistan Pesticides Profile: Factors that Increase Risks from Agrochemicals

The use of pesticides in Pakistan began in 1952 with the introduction of an aerial spraying program on the key crops such as cotton, rice and sugarcane. In addition, pesticides were used for desert locust plague control, organized through an international network coordinated by the FAO. Since then, pesticide use has increased and spread to all crops and agricultural production.

According to World Wildlife Fund (http://www.wwfpak.org/toxics_chemical.php), "The pesticide business started in Pakistan in 1954 with the import of 254 metric tons of formulated product, increasing to 20,648 metric tons in 1986-87 and 44,872 tons in 1998. More than 70-80% of pesticides used in this country are being used on cotton crops. In 1997-98, pesticides were used on 93.9% of the total cropped area of cotton, 86.9% of sugar cane, 70% of rice paddy, and 14.5% of fruit and vegetables. Use of pesticides is increasing at the rate of 25% a year."

As the result of a strong media campaign by about 200 local, national and multinational companies with a distribution network of some 6,000 dealers, farmers believe that it is essential to use pesticides. The import bill of pesticides increased from Rs. 225 million in 1980-89 to Rs. 5,272 million in 1996-97. The sprayed area has increased from 1.8 million hectares to 3.8 million hectares (18% of the cropped area) in 1991. Due to a complex cropping system and small land holdings, ground spray is preferred, with aerial spraying restricted to epidemics. While playing a key role in protecting plants, pesticide use also causes problems like resistance in pests, persistence of toxins in the eco-system, and health problems for field workers, food consumers and dealers. According to a recent report by the Pakistan Agricultural Research Council (PARC), as many as 10,000 farmers are poisoned annually by indiscriminate use of pesticides in cotton growing rural areas only.

In February 2000, the Punjab Assembly was told that about 3,800 tons of obsolete and outdated pesticides were stored in the Punjab Agriculture Department warehouses, but could not be disposed of due to lack of funds. An estimated 1,935 stockpiles of obsolete pesticides in the 41 agriculturally active districts of Pakistan were threatening the lives of thousands of residents. In 2001, over 317 tons of these obsolete pesticides were removed by the Netherlands. As of 2011, many tons of obsolete pesticides remain, awaiting disposal.

Pesticide manufacture, import and usage are controlled by the 1971 Agricultural Pesticides Ordinance, and the 1973 Agriculture Pesticide Rules. As of 2011, 23 pesticides have been de-registered and their import banned. Most of these are Prior Informed Consent (PIC) and Persistent Organic Pollutant (POPs)

Treaty chemicals. Imports of banned pesticides, their illegal storage in godowns, pilferage from warehouses and adulteration are problems related to lack of implementation of the pesticide ordinance.

## Pesticide Informal/Illicit Import to Pakistan

There are no accurate records on quantities or types of pesticides informally/illegally imported to Pakistan; however, there is evidence in markets that these imports exist. Proximity to India and China assures that low quality products will enter Pakistan and that many of these will not be registered and the label quality will be sub-optimal.

## Pesticide Production in Pakistan

Local pesticide manufacturing in Pakistan is very limited and is restricted to Aluminium phosphide, Copper oxychloride and Zinc phosphide only. There are over two dozen formulation plants in the country. For local formulation, the technical grade of a pesticide and other substances including emulsifiers, carriers, stabilizers and so on are imported separately, which, together with a solvent, generally xylene (locally available), are blended in precise proportions to produce the finished product. Due to increasing consumption of pesticides, different advanced technologies are required for new formulations. No new information was available in 2013 or 2104.

## Pesticide Packaging, Repackaging & Labeling Quality in Pakistan

### Packaging

According to above-referenced report, “All packaging is done at registered plants using automatic/semi-automatic filling system. Most liquid pesticides, depending on their chemical nature, are filled in CO-EX and PET bottles or tin cans. Bottles have seals, caps and shrink wraps over them. Powder pesticides are packed in hermetically sealed sachets and granules are packed in plastic bags further contained in cotton bags. The packaging ensures that pesticides are not deteriorated during their shelf-lives as well as there is no leakage.”

### Repackaging

No manual re-packing/ re-filling is permitted. The formulators/re-packers are likewise required to have arrangements of safe storage, proper waste disposal and regular medical checkup of workers. The importers/formulators are required to undertake to supervise re-packing/re-filling and labeling processes carried out at a plant duly registered and pass on pesticides to the distributors, dealers/vendors only in retail packing. No person can store pesticides unless permission for the same is issued to him.

### Labeling

The Agricultural Pesticides Rules provides an exhaustive guideline for labeling following the FAO Guideline covering necessary aspects of safety. Appropriate warning symbol in accordance with the WHO’s recommendation is displayed on label. Withholding period of pesticides is also required to be mentioned.

Packaging and labeling quality is variable in Pakistan, with large multinational companies following recommended best practices and smaller companies from India and China not. Proximity to India and China assures that low quality products will enter Pakistan and that the packaging and label qualities will be sub-optimal. USAID project farmers will need to be informed of this trend and advised not to use sub-optimal products not properly packaged or labeled.

## Current Pesticide Consumption in the Agriculture Sector

Plant protection through the use of pesticides has grown from about 915 tons (230 tons active ingredient) in 1981 to 129,000 tons (28,500 tons of active ingredients) in 2004.

With regard to use, the most heavily treated crop is cotton followed by paddy rice, sugarcane, fruits and vegetables. By itself, cotton accounts for about 70% of the total consumption of pesticides active ingredient; this has resulted in the exceptional rise in cotton production in the country. In 2007, Pakistani farmers cut pesticide use on cotton significantly as a result of FAO FFS programs.[87]

## Pakistan's Pesticide Registration and Regulation System

Before 1971, pesticides to be imported were standardized by the Federal Government of Pakistan through DPP, since no rules and regulations were in place. In 1971, the Agricultural Pesticides Ordinance (APO) was promulgated to regulate import, manufacture, formulation, sale, distribution, use and advertisement of pesticides. In 1973, under this APO, Agricultural Pesticides Rules were made and the entire pesticide regulations were put under regular standardization and registration with the help of Provincial Agriculture Departments.

## Pakistan's Ability to Enforce Regulations on Distribution, Storage, Use, & Disposal of Pesticides

### National Legislation and Enforcement

According to a Pakistani government report (Country Report on International Code of Conduct on the Distribution and Use of Pesticides, 2005), "National legislation exists in the form of Agricultural Pesticides Ordinance 1971 which is supported by the Agricultural Pesticides Rules 1973. The Rules are amended from time to with the approval of Agricultural Pesticides Technical Advisory Committee (APTAC). APTAC is at liberty to nominate sub committees and can entrust them specific duties.

Liberalization of pesticide trade had been welcomed because it had given benefit to the farmers. Unfortunately, this has not been entirely problem free. Some unscrupulous elements found opportunity to indulge in unethical activities such as:

- Formulating pesticides using active ingredient in substandard quantity
- Adulteration at supply chain, packing, distribution and marketing level

These malpractices are affecting the plant protection quality and causing damage to the environment.

### Testing, Quality Control and Effects in the Field

The legislation on the specifications of pesticides already exists in the Agricultural Pesticides Rules 1973.

The check on the quality of pesticides, curbing the practice of sale of adulterated / sub-standard pesticides, is maintained through network of inspectors and pesticides laboratories. Officers of provincial Agriculture Department are appointed as inspectors. Their position is as follows:

| | | |
|---|---|---|
| Punjab | – | 232 |
| Sindh | – | 074 |
| N. W. F. P | – | 157 |

[87] http://www.fao.org/newsroom/en/field/2007/1000497/index.html

| | | |
|---|---|---|
| Baluchistan | – | 092 |
| Federal | – | 015 |

There are at present pesticides 10 laboratories with Public/Semi-Government sector, 29 with the private sector. Additionally under new legislation 50 repackaging units are also required to established pesticides laboratories.

### Pakistan Health and Environment Policy and Mitigation

According to a Pakistani government report (Country Report on International Code of Conduct on the Distribution and Use of Pesticides, 2005), Government with the coordination of industry takes care of human health and the Environment. Rules 37 to 41 specially mention all the requirements, which are necessary for Health and Environment. There are regular surveys on occupational poisoning cases among farmers and industrial workers. Two poison centers are established in the country. One is in Faisalabad and the other is in Karachi.

### Pakistan's Adoption of Prior Informed Consent (PIC) Procedures

In 1999, Pakistan signed the PIC convention treaty. And, it has now banned the import all of the PIC chemicals. The extent to which additional PIC chemicals enter the country is not known, but it is certain to occur due to lack of sufficient border control and enforcement resources.

### Current Pesticide Storage, Handling and Safety Procedures in the Sector Being Studied

According to a Pakistani government report (Country Report on International Code of Conduct on the Distribution and Use of Pesticides, 2005, no more recent updates found), the Government has taken measures to ensure safety in use of pesticides. Persons not having prior approval of their activities from the government are not permitted to produce pesticides. The government has enforced legislation requiring registration of pesticides dealers/venders, distributors, formulators and re-packers. The license for dealership/vending is issued only to a person who has been duly trained in safe storage, transportation and use of pesticides.

The distributors, inter alia, are required to employ adequate number of Agricultural Graduates to ensure safety in handling and judicious use of pesticides. The formulators/ re-packers are likewise required to have arrangements of safe storage, proper waste disposal and regular medical checkup of workers. No manual re-packing/ re-filling is permitted. The importers/formulators are required to undertake to supervise re-packing/re-filling and labeling processes carried out at a plant duly registered and pass on pesticides to the distributors, dealers/vendors only in retail packing. No person can store pesticides unless permission for the same is issued to him.

### Pakistan Pesticide Application Methods

Foliar application through knap-sack/power sprayers is most popular, followed by the tractor-mounted sprayers. Some pesticides are sprayed by ULV sprayers as well, especially for locust plague control. Granular pesticides are broadcast manually. Use of protective clothing/gears is insufficient due to hot and humid conditions prevailing in the fields. Special protective clothing that is light and comfortable needs to be procured for USAID supported clients.

## Phasing Out Severely Toxic Pesticides in Pakistan

According to a Pakistani government report (Country Report on International Code of Conduct on the Distribution and Use of Pesticides, 2005), "Pakistan is the one of the few countries in the region to have banned use of all severely toxic and hazardous pesticides included in the PIC and POP list in the early 1990s. In addition to PIC/POP pesticides, several other pesticides have also been banned. The government has also banned all formulations of monocrotophos and methamidophos. Regardless, POPs and PIC chemicals still enter Pakistan via informal routes.

## Additional Pesticide Challenges in Pakistan

A Pakistani government report (Country Report on International Code of Conduct on the Distribution and Use of Pesticides, 2005[88]) found the following challenges to pesticide use and safety:

### Lack of Awareness

Pakistani farmers have inadequate knowledge about pesticides as to their suitability, application techniques and safety measures. This is one of the reasons of poor pest control, environmental pollution and health problems in some areas. Programs for guidance of the farmers in this respect are far and few. The pesticide industry does not put sufficient resources on dissemination of knowledge on pests, pesticides, environment and management techniques. In this area there is great scope of extension work in the public sector.

### Identification of pest problem

The stage of a particular insect pest is extremely important while determining the need for chemical treatment. Many Pakistani farmers cannot correctly identify crop pests and diseases correctly.

### Selection of pesticides

Normally selective chemicals appear to offer an almost ideal means of pest control. However, only a few such chemicals have been discovered and developed for commercial use. The pesticides that are harmless to predators and parasites are ideal for IPM program. Most Pakistani farmers do not understand pesticide selectivity. Pesticides like abamectin and spinosad are known to be selective in their mode of action. Until more selective pesticides are commercially available at reasonable cost, more judicious use of pesticides should be made.

### Under-dosing

Under dosing of pesticide brings more harm than benefit in the shape of triggering development of resistance in the pests. To get good control of pest, the recommended doses must be used. Sometimes the farmers reduce the dose thinking that the pest pressure is low. Under dosing is helping in the resurgence of the pests. Insects develop resistance to insecticides more rapidly if under dosing is used. Small farmers tend to use less dose of pesticide.

### Lack of Use of Safety Equipment/PPE

One USAID I-LED staff in 2007 said it all with the following: "Inshallah we'll get some IPM/pesticide training that might reduce use but realistically farmers are unlikely to follow most pesticide dosages or PPE recommendations as equipment is uncomfortable to wear/expensive but more to the point they fail to see the need despite the fact that they know these are poisonous. Best we might hope for is for them to

[88] http://www.fao.org/docrep/008/af340e/af340e0g.htm#bm16

wear an old shalwal-kamise and change out of this after spraying/handling chemicals but unlikely shoes or boots.  And perhaps washing with soap as well as water but that might be hoping for too much."

### Obsolete Pesticides in Pakistan

The national Pakistani Agricultural Pesticides Rules state that: "the destruction and removal of the empty packages and pesticides remains shall be affected in such a manner that sources of water supply are not contaminated.  The unclean packages shall be destroyed in a way as to preclude the possibility of their being reused for any purpose other than as base material. Further procedures for disposal of surplus pesticides and pesticides containers have been notified in 1984 encompassing small use, commercial and municipal use, in situ-disposal; organized disposal and landfill disposal sites."

Still, according to (http://www.unescap.org/DRPAD/VC/CONFERENCE/ex_pk_17_dop.htm) the United Nations, Pakistan holds a large stock of obsolete pesticides. The stocks accumulated up until 1980, when national pesticide requirements were purchased centrally by the Government. The quantity has been estimated to lie between 3,000 and 5,000 tons. The stocks are held in an estimated 200 major stores (ton quantities) and up to 1,700 Field Assistant stores (typically containing tens to hundreds of kilograms). The stocks are predominantly in the cotton growing areas of the Provinces of Sind and Punjab, but there are also stocks in Northwest Frontier Province and Balochistan.

The stocks comprise a large range of formulated pesticide types predominantly organophosphate and organochlorine insecticides. The main hazard associated with the pesticides is their acute toxicity, with some of the product active ingredients falling within the highest category of toxicity according to the WHO system of classification, namely "extremely hazardous". The stocks, having been held for around two decades or more, are now in a dilapidated condition, with considerable leakage, and pilferage. This presents a serious risk to those who have to enter the stores. Because store integrity and security is not good in some locations, it also presents a serious risk to the local communities and to the environment. There is apparently some evidence of contaminated wells. There have been complaints and expressions of concern from some communities.

Fortunately, after pesticide purchase moved to the private sector in 1980, there has been little subsequent accumulation of pesticide stock sand hence further stock accumulation is not seen as a problem for the future. The problem can, therefore, be restricted to how to collect and dispose of the existing obsolete stocks in a safe and environmentally responsible manner.

There have been several significant past initiatives to deal with the problem. The first was in 1987 when USAID sponsored the visit to Pakistan of a team of hazardous waste disposal experts to assess the situation. The team estimated the stocks and associated hazardous materials at some 8,000 tones. Some of the stores visited were considered to present a serious danger to those entering them. The team made recommendations for the disposal of the stocks.

Following the above visit, USAID and USEPA, in collaboration with the Government of Pakistan and other, carried out a disposal experiment (1.5 tons of pesticide) using a modern cement kiln at D.G. Khan. Although the experiment was claimed a technical success, there was controversy related to apparent bird deaths and a safety concern from the nearby community, and a local opposition to cement kiln use developed.

Subsequently a proposal to dump these expired pesticides in the desert areas of Punjab province remained under consideration of the provincial government. In fact some land fill sites were also prepared. However, before implementation could progress, several NGOs voiced their concern against this approach from environmental point of view. As a result this proposal was shelved.

Later on, several other half-hearted attempts to deal with the problem remained under consideration. None came to fruition, partially due to the inability of the Government organizations to find a viable solution to this problem as well as public opposition of any unscientifically proven method of disposal of these expired pesticides.

The unsuccessful results of past efforts in this regard brought The Royal Netherlands Embassy (RNE), Islamabad aware of this problem in 1996 relating to the obsolete stock problem and the potential serious risk it presented. It was also recognized that some of the stocks may have originated from the Netherlands and hence they must be called to assist in the disposal of the pesticide stocks. Against this background the RNE commissioned a full-scale study with the following findings:

The current level of stock is not known, neither are the numbers of stores and their locations. The best estimate is 3,000 tons of pesticide stocks and perhaps 500 tons of associated waste.

There are well-established procedures and technical options for dealing with the problem, and they have been used successfully in a number of recent (albeit smaller) international projects. The only generally acceptable disposal process for the collected stocks and waste is high temperature incineration in special incinerators having flu gas treatment units that meet internationally acceptable emission standards. Most of the merchant incinerators are located in Europe.

A number of international hazardous waste disposal companies have submitted offers for undertaking the work, involving offshore incineration.

Although the stock repacking and site clean-up elements are well defined procedurally, there are several final disposal options (all involving high temperature incineration). The options are:

- Off-shore incineration in Europe
- Off-shore incineration in India
- Incineration in local cement kilns
- Installing a local rotary kiln incinerator in Pakistan.

On the basis of above, a Scoping Inventory is being prepared to identify those stores and stocks posing the greatest risk to the communities. Following a Pilot Project would be considered out to collect and dispose, by offshore incineration in Europe, of 500 tons of the highest risk stocks/stores. Happening concurrently, is the task to carry out a detailed inventory of the remaining stores and train a local team to carry out the hazardous and complex task of subsequent site clean-ups and product repacking. This project is estimated to cost US$ 2.2 million, including Scoping Inventory and would be implemented in about 2 years.

Once the detailed inventory produced during the Pilot Project becomes available, a feasibility study of the local rotary kiln and regional options would be completed, cost-estimated and evaluated, then to be followed by the collection and disposal of the remaining some 3,000 tons of stocks and associated materials. The outcome of this could either be to continue with offshore incineration or to switch to one of the other options (or a mix).

The latest proposal prima facia supported by the donor has yet to achieve full national consensus on the soundness of the approach and its technical efficiency on which consultation must commence immediately for their widest acceptance and support.

Crop Life International points out “in 2001, a pilot project initiated and sponsored by the Royal Netherlands Embassy (RNE) in Islamabad, was completed. On behalf of the RNE, the Pesticide Disposal Project of GTZ managed and carried out the basic survey for the disposal operation, the safeguarding and disposal of 323 tons of obsolete pesticides and associated waste from 13 high risk stores in the Province of Punjab and a complete survey of all 168 pesticide stores in Punjab Province. The 13 warehouses were owned by the Punjab Department of Agriculture and the stocks had been held since the late 1970s. Member companies of CropLife International paid the cost of incineration of 94 tons of the products (those they had either manufactured or supplied). The collection, re-packing, cleaning of storage areas, shipping and incineration activities were undertaken by AVR, the Dutch hazardous waste disposal company, subcontracted and supervised by GTZ. The GTZ survey indicated that there might be around another 1000 tons of obsolete stocks in the Province of Punjab. The Pakistan authorities hope that new donors will help fund further projects to collect and destroy these stocks.

In 2001, GTZ, the Environmental Protection Agency (EPA) of the North West Frontier Province of Pakistan and Bayer CropScience successfully completed an obsolete stocks disposal project in Peshawar, the provincial capital. Sixty tons of Gusathion, an insecticide for cotton – purchased by the government some 20 years ago – had been mistakenly transported to a government warehouse in a non-cotton growing area. As a result it lay unused and eventually deteriorated. The Pesticide Disposal Project of GTZ managed and carried out the collection and disposal operation. The product was repacked and transported to the United Kingdom, where Shanks Corporation incinerated it. GTZ and Bayer CropScience shared the technical and financial contributions.

In 2004, discussions were initiated between the Pakistan Environmental Protection Agency and GTZ for the collection and disposal of 15 tons of dust containing low levels of endrin, held at a depot at Malir, near Karachi. Shell, one of the original manufacturers of endrin, was to fund the project. However, before the project could start, the depot was cleared of pesticides and the site redeveloped. Until 1980, all pesticides in Pakistan were purchased centrally and then distributed to farmers. A private market was subsequently introduced, which had the beneficial effect of reducing considerably the accumulation of obsolete stocks.

The latest (http://www.fao.org/agriculture/crops/obsolete-pesticides/where-stocks/asia-stocks/en/) FAO report on obsolete pesticide disposal, from 2006, states that at that time, Pakistan still had 1,361,041 Kg of obsolete pesticides remaining. In 2012, the GEF Scientific and Technical Advisory Panel (STAP) performed a screening, with UNDP, titled: Comprehensive Reduction and Elimination of Persistent Organic Pollutants in Pakistan[89].

The POPs inventory for Pakistan as listed in the country NIP (National Implementation Plan), inter alia includes 82,890 tons of PCB-contaminated transformer oils, an annual emission of almost 30 Kg TEQ, and 6,033 tons of POPs pesticide stockpiles. This project aims to dispose of 1,200 tons of POPs pesticides and to dispose of 300 tons of PCB equipment. The study concludes: "The current POPs stockpile (PCBs and pesticides) in Pakistan seems to be particularly large." It further notes: "It is not clear how the disposal will be done."

[89] http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/POPs/Pakistan%20-%20(4477)%20-%20Comprehensive%20Reduction%20and%20Elimination%20of%20Persist/4477-2012-01-27-144906-STAPReviewAgency.pdf

# Annex 18: Results from Questionnaire Survey of USAID Pakistan-Supported Projects

**2014 Questionnaire for Pakistan Program PERSUAP (Pesticide Evaluation Report and Safe Use Action Plan) Process and Results**

**Name of Project that may involve use of pesticides: ________________________________**

**USAID Projects that responded to this questionnaire:**

**Agriculture**

FIRMS project date palm orchards, ag sector pest control

FIRMS project potato field, ag sector pest control

FIRMS project mango orchard, ag sector pest control

The Agribusiness Project, in agriculture, livestock pests and right of way dam weed clearing

Balochistan Agriculture Project, pest control and right of way dam weed clearing

Satpara Development Project, in horticulture, livestock and dam weed clearing

Conflict Victims Support program, livestock and warehouse pest control

Dairy Development project, livestock pest control

**Health**

Women's Hostel Project, FCC Lahore, mosquito and termite control

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure, microbicide use

**Construction**

A&E Services for Sindh Basic Education Program (SBEP), construction termiticides use

A&E Services for Municipal Services Program, Town-1, Peshawar, construction termiticides use

Pakistan Reconstruction Program, construction termiticides use

Construction of Ten (10) Faculty of Education Complexes in Pakistan, termiticides use

**Pesticides = insecticides, miticides, fungicides, microbicides, herbicides, mosquito killing chemicals, termiticides and others**

**Project Sector that may use pesticides (Please mark sector(s) worked on)**

**Agriculture** (Seed, Greenhouse, Nursery, Orchard and Field) __________

**Livestock/Veterinary** Treatments (Ticks/Acaricides) __________

**Food Security** (Warehouse and Food Fumigation) __________

**Water and Sanitation** (Microbicides) __________

**Avian Influenza** (Disinfectants) __________

**Human Health** (Malaria, Dengue mosquitocides) __________

**Construction** (Termite termiticides) __________

**Right of Way Weeds** (along roads, **dams**, canals, electric lines, with herbicides) __________

Other (specify) ______________________ __________

## I. Use of 2011-2013 Umbrella/Programmatic PERSUAP

**1. During 2011-2013, did your project partners or beneficiaries use any pesticides rejected by the 2011-2013 PERSUAP?**

**Project Reponses:** *None of the projects supported the use of pesticides rejected by the 2013 PERSUAP.*

**2. Did your project perform pesticide use safety training including Personal Protection Equipment (PPE)? How many times, how many trainees, where and when?**

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (2013 safety/IPM training for 45 trainees)

FIRMS project potato field sector pest control

- (2013 safety/IPM training for 164 trainees)

FIRMS project mango orchard sector pest control

- (26 SMEs trained in IPM and safety)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (1100 people trained on IPM and safety)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (3 trainings, 63 people in 2012)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (The project did not use pesticides so far. It may start using pesticides in the coming growing season from May onward. The project will start Farmers Field School for different crops and that FFS will be supported by comprehensive trainings in safe use and proper disposal of pesticides)

Conflict Victims Support program livestock and warehouse pest control

- (Currently, the use of pesticides has not been a reason of concern, hence no trainings were delivered. However, the use of chemicals by the beneficiaries as a consequence of project interventions is anticipated. In this regard, all necessary measures, including the preparation of

EMMP containing the necessary mitigation measures (safety trainings etc.) shall be carried out)

Dairy Development project livestock pest control

- (Although the project is not using pesticides, however an overall training was conducted related to the safe handling of medicines. Environment specialist conducted on site sessions with the field staff at Multan and Vehari site where environment specialist told the health safety measures while treating the animals and their health impacts. On-site training was conducted in Feb-March 2013 and almost all the master trainers joined that session from the respective sites)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (Yes, 4 times approximately, 5 trainees, biannually at site)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (Yes, at 5 schools in District Khairpur (Taluka Thari Mirwah and Khairpur) approx. 60 trainees and conducted before anti-termite application by the construction contractor)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (NA, for time being)

Pakistan Reconstruction Program construction termiticides use

- (Only Biflex Bifenthrin is used, which is approved under 2011 PERSUAP; We have only allowed the authorized implementers to execute this job. i.e., FMC Biflex personnel. In addition, CCI environmental specialist trained site staff for the implementation of the PERSUAP, 111 people were trained in 2013/2014)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (no, project not yet awarded)

## II. Specific Questions for 2014 Pesticide Evaluation Report (PER)

For each of the following sectors:

- Agriculture/Livestock/Processing/Slaughter/Food Storage (controlling insects, mites, nematodes, rodents, birds, and diseases)
- Health/Mosquito Control (controlling mosquitoes)
- Water/Sanitation (controlling microbes)
- Construction/Maintenance (controlling termites, weeds and brush)

Please answer each of the following 12 questions required by USAID's 22CFR216.3 (b) 12-factor analysis required for PERSUAPs:

**Pesticide procedures factor a: USEPA & local registration status of the proposed pesticide**

Send us a list of pesticides that you or your beneficiaries use

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- Bavistin (Benzimidazole group – allowed as per PERSUAP)
- Topsin M (Thiophanate Methyl - allowed as per PERSUAP)
- Copper Oxychloride (allowed as per PERSUAP)

FIRMS project potato field sector pest control

- Dithane M45 WP (Mancozeb – allowed as per PERSUAP)
- Antracol (Dithiocarbamate - allowed as per PERSUAP)
- Ridomil Gold 68 WP (Metalyxyl - allowed as per PERSUAP)
- Topsin M (Thiophanate Methyl - allowed as per PERSUAP)
- Benalate (Benzimidazole group – allowed as per PERSUAP)

FIRMS project mango orchard sector pest control

- Triazophos (not allowed as per PERSUAP, but farmers use on their own)
- Nitenpyram (not allowed as per PERSUAP, but farmers use on their own)
- Bifenthrin(allowed as per PERSUAP)
- Chlorpyrephos (allowed as per PERSUAP)
- Actemarid (allowed as per PERSUAP)
- Lamdacyhalothrin (allowed as per PERSUAP)
- Immidacloprid (allowed as per PERSUAP)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (same as last year = lots of pesticides)

Balochistan Agriculture Project, pest control and right of way dam weed clearing

- Topick 16 WP in wheat for weed control
- Dithane M-45 is used in apple orchards for the control of the fungal diseases

Satpara Development Project in horticulture, livestock and dam weed clearing

- (As mentioned above, the project did not use pesticides so far. In the coming growing season from May onward some crops may need pesticides; the project will make a list in the light of the PERSUAP and the local availability of the pesticides and may share that list by the end of May 2014)

Conflict Victims Support program, livestock and warehouse pest control

- (NA, the SOW does not contain pesticide purchase)

Dairy Development project, livestock pest control

- (Dairy project is using medicines/drugs for the treatment of animals and all of these medicines are regulated by Food and Drug Administration as USEPA site clearly says that" Drugs used to control diseases of humans or animals (such as livestock and pets) are not considered pesticides; such drugs are regulated by the Food and Drug Administration"(http://www.epa.gov/pesticides/about/#safer). Drugs which dairy project is using are approved from USAID against the approved list of FDA active ingredients. List of the medicines/drugs used and approved FDA list of active ingredients are attached for reference; however chemical Sagowan use is mentioned later)

**Health**

Women's Hostel Project, FCC Lahore, mosquito and termite control

- Mirage 25EC (containing imidacloprid)
- Temiphose
- Deltamethrine

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure, microbicide use

- Sodium Hypochlorite is proposed to be used as disinfectant in water filtration

**Construction**

A&E Services for Sindh Basic Education Program (SBEP), construction termiticides use

- (Agenda 25 EC (fipronil) by Bayer distributed by M/s. Jaffer Brothers (Private) Limited)

A&E Services for Municipal Services Program, Town-1, Peshawar, construction termiticides use

- (Agenda 25 EC (fipronil) by Bayer distributed by M/s. Jaffer Brothers (Private) Limited. Imidacloprid made by mirage)

Pakistan Reconstruction Program, construction termiticides use

- Biflex Bifenthrin

Construction of Ten (10) Faculty of Education Complexes in Pakistan, termiticides use

- (none, project not yet awarded)

**<u>Pesticide procedures factor b</u>: Basis for selection of the pesticide**

What are the primary bases for your partners/beneficiaries to select pesticides, or mosquito insecticides, or microbicides, or termiticides, or herbicides in your country (circle all that apply)?

- price, efficacy, availability, safety, environmental protection, recommendation by neighbor, recommendation by pesticide store employee, or other?

## Project Reponses

### Agriculture

FIRMS project date palm orchards, sector pest control

- (data not collected)

FIRMS project potato field, sector pest control

- (data not collected)

FIRMS project mango orchard, sector pest control

- (data not collected)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (price, efficacy, availability, safety, environmental protection)

Balochistan Agriculture Project, pest control and right of way dam weed clearing

- (price, efficacy, availability, safety, extension service advice)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (price, efficacy, availability, safety, extension service advice)

Conflict Victims Support program, livestock and warehouse pest control

- (NA)

Dairy Development project, livestock pest control

- (price, efficacy, availability, safety, environmental protection)

### Health

Women's Hostel Project, FCC Lahore mosquito and termite control

- (advice in PERSUAP Annex 1)

### Water and Sanitation

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (price, efficacy, availability, safety)

### Construction

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (price, efficacy, availability, safety, environmental protection)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (price, efficacy, availability, safety, environmental protection)

Pakistan Reconstruction Program construction termiticides use

- (environmental protection)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (availability, safety, environmental protection)

**<u>Pesticide procedures factor c</u>: Extent to which the proposed pesticide use is, or could be, part of an IPM program**:

Let us know IPM tools and tactics used by you or your beneficiaries.

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (data not collected)

FIRMS project potato field sector pest control

- (data not collected)

FIRMS project mango orchard sector pest control (data not collected)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (none)

Balochistan Agriculture Project, pest control and right of way dam weed clearing

- (IPM is used in orchard by the farmers. It includes, plowing of land at certain time of the year, using pheromone traps, and lighting at night time in the vicinity of orchards and use of fungicide)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (As mentioned above, the project did not use any pesticides so far. The project established 24 passive green-houses and there was an EMMP for every greenhouse but these were in the extreme winter months and no chance for pests attack. Therefore no IPM was implemented in these greenhouses. From May onward vegetable will be grown in the open field and an IPM program will be developed for every activity)

Conflict Victims Support program, livestock and warehouse pest control

- (NA)

Dairy Development project, livestock pest control

- (NA)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (IPM for building and School is in practice at project)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (NA)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (No IPM tools are used)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (No IPM tools are used)

Pakistan Reconstruction Program construction termiticides use

- (safety practices are mentioned in place of IPM practices)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (NA)

**Pesticide procedures factor d: Proposed method or methods of application, including the availability of application and safety equipment**

Which of the following pesticide application methods are used (circle all that apply)?

Batch seed treatment machinery, hand-pump (piston or diaphragm) backpack sprayer with wand, motorized backpack sprayer, portable tank/pump/hose/lance unit, hand-held micro-ULV sprayers, granular applicators, truck- or tractor-mounted boom sprayers, or sleeve boom or electrostatic sprayers.

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (truck- or tractor-mounted boom sprayers)

FIRMS project potato field sector pest control

- (motorized backpack sprayer)

FIRMS project mango orchard sector pest control

- (truck- or tractor-mounted boom sprayers & motorized backpack sprayers)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (hand-pump (piston or diaphragm) backpack sprayer with wand, motorized backpack sprayer)

Balochistan Agriculture Project, pest control and right of way dam weed clearing

- (hand-pump (piston or diaphragm) backpack sprayer with wand, portable tank/pump/hose/lance unit)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (hand-pump (piston or diaphragm) backpack sprayer with wand)

Conflict Victims Support program, livestock and warehouse pest control

- (NA)

Dairy Development project livestock pest control

- (Direct contacts with medicines are avoided and compliance to the product specifications is observed while treating animals. Gloves are used while treating livestock and face mask are worn during treatment)

**Health**

Women's Hostel Project, FCC Lahore, mosquito and termite control

- (hand-pump (piston or diaphragm) backpack sprayer with wand)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure, microbicide use

- (portable tank/pump/hose/lance unit, Sodium Hypochlorite will be stored in chemical dosing tanks. Further it will be pumped to Chlorine contact tank through chemical dosing pumps )

**Construction**

A&E Services for Sindh Basic Education Program (SBEP), construction termiticides use

- (portable tank/pump/hose/lance unit)

A&E Services for Municipal Services Program, Town-1, Peshawar, construction termiticides use

- (portable tank/pump/hose/lance unit)

Pakistan Reconstruction Program, construction termiticides use

- (hand-pump (piston or diaphragm) backpack sprayer with wand, motorized backpack sprayer)

Construction of Ten (10) Faculty of Education Complexes in Pakistan, termiticides use

- (backpack sprayer with wand)

**Pesticide procedures factor e: Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards**:

Do you know of any accidental human pesticide poisonings, or kills of fish, birds, honeybees or wildlife?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (no)

FIRMS project potato field sector pest control

- (no)

FIRMS project mango orchard sector pest control

- (no)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (no)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (no)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (no)

Conflict Victims Support program livestock and warehouse pest control

- (no)

Dairy Development project livestock pest control

- (no)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (no)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (no)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (no)

Pakistan Reconstruction Program construction termiticides use

- (no)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (none)

**<u>Pesticide procedures factor f</u>: Effectiveness of the requested pesticide for the proposed use**:

Do any of the pesticides you propose or promote to your beneficiaries, or beneficiaries use, have a record of showing signs of working less and less effectively over time in your country?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (no)

FIRMS project potato field sector pest control

- (data not collected)

FIRMS project mango orchard sector pest control

- (no, data not collected))

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (yes)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (no)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (The project is not at that stage of recommendation, by the end of May a list of proposed pesticides will be ready and then we can look into it if any of the recommended pesticide is getting less effective)

Conflict Victims Support program livestock and warehouse pest control

- (NA)

Dairy Development project livestock pest control

- (no)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (no)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (no)

Pakistan Reconstruction Program construction termiticides use

- (no)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (no)

**Pesticide procedures factor g: Compatibility of the proposed pesticide use with target and non-target ecosystems**:

Do your beneficiaries or your project field staff have information on the impacts of the pesticides they use on beneficial non-target organisms, like honeybees, predators, parasites and parasitoids, in the crop field?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (no)

FIRMS project potato field sector pest control

- (data not collected, but staff aware of issues)

FIRMS project mango orchard sector pest control

- (data not collected, but staff aware of issues)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (no)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (yes, the project does not have solid data but there is a general understanding that pesticides have an adverse impact on the beneficial insects)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (no)

Conflict Victims Support program livestock and warehouse pest control

- (Currently, no such database/information has been collected. In anticipation of any indirect usage and impacts of pesticides, such data shall be collected)

Dairy Development project livestock pest control

- (No pesticides are used in the crop field by the Dairy project so the query is not applicable; however, medicine like sagowan has some impact on non-target organisms)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (no)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (no)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (no)

Pakistan Reconstruction Program construction termiticides use

- (no)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (no)

**Pesticide procedures factor h: Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils**:

Does your project have information or a database on the environmental or ecological conditions under which the pesticides will likely be used by beneficiaries, including soil types and characteristics, hydrology (watersheds, groundwater and surface water resources), geography, climate, protected areas with endangered flora and fauna?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (no)

FIRMS project potato field sector pest control

- (no)

FIRMS project mango orchard sector pest control

- (no)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (yes, in 2013 PERSUAP)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (yes, in 2013 PERSUAP)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (yes, the PERSUAP will be strictly followed)

Conflict Victims Support program livestock and warehouse pest control

- (NA)

Dairy Development project livestock pest control

- (NA, except for Sagowan)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (no)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (no)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (no)

Pakistan Reconstruction Program construction termiticides use

- (no)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (no)

**Pesticide procedures factor i: Availability of other pesticides or non-chemical control methods**:

Let us know if you or your beneficiaries use any artisanal or homemade pesticides.

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (data not collected)

FIRMS project potato field sector pest control

- (data not collected)

FIRMS project mango orchard sector pest control

- (data not collected)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (no)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (no)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (no)

Conflict Victims Support program livestock and warehouse pest control

- (NA)

Dairy Development project livestock pest control

- (no)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (NA)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (none)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (No, other types of pesticides are not used)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (Other types of pesticides are not used)

Pakistan Reconstruction Program construction termiticides use

- (NA)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (none)

**Pesticide procedures factor j: Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide**

Do you feel that there are sufficient government extension or private sector mechanisms in place in your country to effectively regulate or control the distribution, storage, use, use of safety equipment and disposal of pesticides that your beneficiaries will use?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (no)

FIRMS project potato field sector pest control

- (no comment)

FIRMS project mango orchard sector pest control

- (no comment)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (no, lack of capacity and resources)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (no, resources for implementation are lacking)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (no)

Conflict Victims Support program livestock and warehouse pest control

- (Despite of the existence of regulatory jurisdictions, the implementation and systematization of pesticide usage is grossly mismanaged. There are institutions like Environmental Protection Agency at Federal level and their counterparts in the provinces as well as plethora of regulations; however, the issue remains the implementation of such laws/regulations. Stricter policies related to the import/sales of chemicals need to be in place. Grass root level sensitization related to IPM and its advantages need to be encouraged)

Dairy Development project livestock pest control

- (NA, Since Dairy project is not using any hazardous pesticide so this question is not applicable for dairy project. However, Proper landfill sites are not available for the disposal of the used drug bottles all over Pakistan. Other than that storage and safety equipment could be managed appropriately)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (yes)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (yes)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (yes)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (yes)

Pakistan Reconstruction Program construction termiticides use

- (no, in our understanding regulations does not exist or are not being implemented by the government agencies regarding the storage and safety requirements for the use of the pesticides)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (yes)

**<u>Pesticide procedures factor k</u>: Provision for training of users and applicators**:

Does your project have planned Integrated Pest Management (IPM) training including pesticide selection and safety training for project field staff and beneficiaries?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (yes, training performed)

FIRMS project potato field sector pest control

- (yes, training performed)

FIRMS project mango orchard sector pest control

- (yes, training performed)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (no, but the plan is being developed)

Balochistan Agriculture Project, pest control and right of way dam weed clearing

- (no)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (IPM trainings schedule and training manual will be available by the end of May, 2014. Currently the project is searching for some technical expertise for this activity. The IPM will be implemented through FFS approach)

Conflict Victims Support program, livestock and warehouse pest control

- (no, IPM trainings have not been focused till yet but as mentioned earlier, they shall be included where any pesticide usage is apprehended)

Dairy Development project, livestock pest control

- (NA)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (no)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (no)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (no)

Pakistan Reconstruction Program construction termiticides use

- (Training is conducted for CCI and subcontractor staff on environment and safety. See sample training attached from one of our project. Similar training is conducted on other sites under construction)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (no, pesticide use to be outsourced to specialists)

**<u>Pesticide procedures factor l</u>: Provision made for monitoring the use and effectiveness of pesticides**:

Does your project have in place a monitoring system, like an Environmental Monitoring and Mitigation Plan (EMMP), for tracking and evaluating the risks and benefits of IPM/pesticide use?

**Project Reponses**

**Agriculture**

FIRMS project date palm orchards sector pest control

- (no)

FIRMS project potato field sector pest control

- (yes, EMMP and ERR completed)

FIRMS project mango orchard sector pest control

- (yes, EMMP completed)

The Agribusiness Project in agriculture, livestock pests and right of way dam weed clearing

- (yes, EMMP completed)

Balochistan Agriculture Project pest control and right of way dam weed clearing

- (no)

Satpara Development Project in horticulture, livestock and dam weed clearing

- (yes, EMMP completed)

Conflict Victims Support program livestock and warehouse pest control

- (yes, EMMP completed)

Dairy Development project livestock pest control

- (yes, EMMP completed)

**Health**

Women's Hostel Project, FCC Lahore mosquito and termite control

- (yes, EMMP completed)

**Water and Sanitation**

A&E Services for Jacobabad Water, Wastewater and Solid Waste Infrastructure microbicide use

- (no)

**Construction**

A&E Services for Sindh Basic Education Program (SBEP) construction termiticides use

- (yes, EMMP completed)

A&E Services for Municipal Services Program, Town-1, Peshawar construction termiticides use

- (yes, EMMP completed)

Pakistan Reconstruction Program construction termiticides use

- (yes, EMMP completed)

Construction of Ten (10) Faculty of Education Complexes in Pakistan termiticides use

- (yes, individual EMMP reports are required by all 10 IEE reports)

## Annex 19: Lists of Banned POPs and Highly Restricted PIC chemicals

### Stockholm Convention on Persistent Organic Pollutants (POPs) Pesticides and Chemicals (http://www.pops.int)

#### Pesticides

- Aldrin
- Chlordane
- *Dichloro-Diphenyl-Trichloroethane (*DDT)*
- Dieldrin
- Endosulfan
- Endrin—*not on PIC list*
- Heptachlor
- Hexachlorobenzene
- Mirex—*not on PIC list*
- Toxaphene
- Lindane

#### Industrial Chemicals

- Polychlorinated Biphenyls (PCBs)
- Alpha hexachlorocyclohexane
- Beta hexachlorocyclohexane
- Chlordecone
- Hexabromobiphenyl
- Hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octabromodiphenyl ether)
- Pentachlorobenzene
- Perfluorooctane sulfonic acid, its salts and perfluorooactane sulfonyl fluoride
- Tetrabromodiphenyl ether and pentabromodiphenyl ether (commercial pentabromodiphenyl ether)

#### Combustion Products

- Dioxins—*not on PIC list* (formed by burning chlorine-based hydrocarbon chemical compounds, like any of the above chemicals )
- Furans—*not on PIC list* (formed by burning pentose compounds, especially plastics)

  * DDT may continue to be used for malaria control in interior residual spraying (IRS)

## Rotterdam Convention on Prior Informed Consent (PIC) Pesticides and Industrial Chemicals (http://www.pic.int)

### Pesticides

- 2,4,5-T and its salts and esters
- Alachlor
- Aldicarb
- Aldrin
- Binapacryl
- Captafol
- Chlordane
- Chlordimeform
- Chlorobenzilate
- DDT
- Dieldrin
- Dinitro-ortho-cresol (DNOC) and its salts (such as ammonium salt, potassium salt and sodium salt)
- Dinoseb and its salts and esters
- 1,2-dibromoethane(EDB)
- Ethylene dichloride
- Ethylene oxide
- Fluoroacetamide
- HCH (mixed isomers)
- Heptachlor
- Hexachlorobenzene
- Lindane
- Mercury compounds including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds
- Monocrotophos
- Parathion
- Pentachlorophenol and its salts and esters
- Toxaphene
- Tributyltin compounds

### Severely Hazardous Pesticide Formulations

- Dustable powder formulations containing a combination of: benomyl at or above 7 per cent, carbofuran at above 10 per cent, thiram at or above 15 per cent.
- Methamidophos (Soluble liquid formulations of the substance that exceed 600 g active ingredient/l)
- Phosphamidon (Soluble liquid formulations of the substance that exceed 1000 g active ingredient/l and mixtures of (E)&(Z) isomers, (Z)-isomer, and (E)-isomer
- Methyl-parathion (emulsifiable concentrates (EC) at or above 19.5% active ingredient and dusts at or above 1.5% active ingredient)

### Industrial Chemicals

- Asbestos Crocidolite
- Asbestos Actinolite
- Asbestos Anthophyllite
- Asbestos Amosite
- Asbestos Tremolite
- Polybrominated biphenyls (PBBs, hexa- octa- and deca-)
- Polychlorinated biphenyls (PCB)
- Polychlorinated terphenyls (PCT)
- Tetraethyl lead
- Tetramethyl lead
- Tris (2,3-dibromopropyl) phosphate